# SIEMENS

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# SIMATIC

# S7-300 SM331;AI 8x12 Bit Getting Started Part 2: Voltage and PT100

**Getting Started** 

#### Safety Guidelines

This manual contains notices you have to observe in order to ensure your personal safety, as well as to prevent damage to property. The notices referring to your personal safety are highlighted in the manual by a safety alert symbol, notices referring only to property damage have no safety alert symbol. These notices shown below are graded according to the degree of danger.



#### Danger

indicates that death or severe personal injury will result if proper precautions are not taken.



# Warning

indicates that death or severe personal injury may result if proper precautions are not taken.

## Caution

with a safety alert symbol, indicates that minor personal injury can result if proper precautions are not taken.

#### Caution

without a safety alert symbol, indicates that property damage can result if proper precautions are not taken.

#### Notice

indicates that an unintended result or situation can occur if the corresponding information is not taken into account.

If more than one degree of danger is present, the warning notice representing the highest degree of danger will be used. A notice warning of injury to persons with a safety alert symbol may also include a warning relating to property damage.

#### **Qualified Personnel**

The device/system may only be set up and used in conjunction with this documentation. Commissioning and operation of a device/system may only be performed by **qualified personnel**. Within the context of the safety notes in this documentation qualified persons are defined as persons who are authorized to commission, ground and label devices, systems and circuits in accordance with established safety practices and standards.

#### **Prescribed Usage**

Note the following:



# Warning

This device may only be used for the applications described in the catalog or the technical description and only in connection with devices or components from other manufacturers which have been approved or recommended by Siemens. Correct, reliable operation of the product requires proper transport, storage, positioning and assembly as well as careful operation and maintenance.

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#### **Disclaimer of Liability**

We have reviewed the contents of this publication to ensure consistency with the hardware and software described. Since variance cannot be precluded entirely, we cannot guarantee full consistency. However, the information in this publication is reviewed regularly and any necessary corrections are included in subsequent editions.

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# Preface

# 1.1 General information

## Purpose of the Getting Started manual

The Getting Started guide gives you a complete overview of the commissioning of analog module SM331. It supports you when installing and parameterizing the hardware of a voltage measuring transducer and a PT100 resistance thermometer. In addition, you will receive an introduction for configuring the analog module with the SIMATIC S7 manager.

The intended readership of Getting Started is a novice with only basic experience in configuring, commissioning, and servicing automation systems.

## What to expect

The procedures, from mounting the module to storing analog values in the STEP7 user program, are explained step-by-step and in detail based on an example. In the following sections you will be introduced to:

- Problem analysis
- Mechanical setup of the example station
- Electrical connection of the example station using conventional wiring
- Electrical connection of the example station using SIMATIC TOP connect system cabling
- Configuration using the SIMATIC Manager
- Creating a small user program with STEP7 which stores the read analog value in a data block
- Triggering and interpreting diagnostic and hardware interrupts

# Preface

1.1 General information

# Prerequisites

# 2.1 Basics

## Basic knowledge

No special knowledge of the field of automation technology is required in order to understand the Getting Started guide. As the configuration of the analog module is done with the STEP7 software, proficiency in STEP7 would be advantageous.

Further information on STEP7 can be found in the electronic manuals that are supplied with STEP7.

You will also need to know how to use computers or PC-like equipment (such as programming devices) with the Windows 95/98/2000/NT or XP operating systems.

#### Required hardware and software

The scope of delivery of the analog module consists of 2 parts:

- SM331 module
- Front panel connector for convenient connection of the power supply and data cables.

Analog module components

Quantity	y Item Order no.	
1	SM 331, Electrically ISOLATED 8 AI, ALARM DIAGNOSTICS	6ES7331-7KF02-0AB0
1	20-pin FRONT CONNECTOR with spring contacts       6ES7392-1BJ00-0AA         Alternatives:       -         - FRONT CONNECTOR WITH 20-PIN SCREW-TYPE       6ES7392-1AJ00-0AA         CONTACTS       6ES7921-3AF00-0AA         - FRONT CONNECTOR MODULE W/ FLAT ROUND CABLE       6ES7921-3AF00-0AA	
1	SIMATIC S7 SHIELDED SUPPORT ELEMENT 6ES7390-5AA00-0AA	
2	SIMATIC S7, SHIELDED CONNECTION TERMINAL F. 1 CABLE W/ 413MM DIAM	6ES7390-5CA00-0AA0

2.1 Basics

The general SIMATIC components required for the example are as follows: SIMATIC material for the example station

Quantity	Item	Order no.
1	POWER SUPPLY LOAD PS 307 AC 120/230V, DC 24V, 5A (incl. power supply jumper) 6ES7307-1EA00-0/	
1	CPU 315-2 DP	6ES7315-2AG10-0AB0
1	MICRO MEMORY CARD, NFLASH, 128KBYTES 6ES7953-8LG00-0AA	
1	SIMATIC S7-300, MOUNTING RAIL L=530MM 6ES7390-1AF30-0AA0	
1	Programming device (PD) with MPI interface and MPI cable PC with suitable interface card	depending on the configuration

If you would like to carry out the example station using SIMATIC TOP connect, you will need the following additional components:

SIMATIC Top connect components

Quantity	Item	Order no.
1	FRONT CONNECTOR MODULE W/ FLAT ROUND CABLE CONNECTION FOR ANALOG MODULES OF THE S7-300 POWER SUPPLY VIA SPRING CLIPS	6ES7921-3AF00-0AA0
2	TERMINAL BLOCK TPA,3-ROW FOR ANALOG MODULES OF THE SIMATIC S7;CONNECTION USING FLAT ROUND CABLE CONNECTIONS VIA SPRING CLIPS	6ES7924-0CC00-0AB0
2	SHIELDING PLATE FOR ANALOG TERMINAL BLOCK	6ES7928-1BA00-0AA0
4	CONNECTOR (RIBBON CABLE CONNECTOR) AS PER DIN 41652, 16-PIN, SNAP-ON/SCREW-ON	6ES7921-3BE10-0AA0
2	SIMATIC S7, SHIELDED CONNECTION TERMINAL F. 1 CABLE W/ 413MM DIAM	6ES7390-5CA00-0AA0
2	SIMATIC S7, SHIELDED CONNECTION TERMINAL. F. 2 CABLES W/ 26MM DIAM EACH	6ES7390-5AB00-0AA0
1	FLAT ROUND CABLE WITH 16 WIRES 0.14 MM <sup>2</sup> LENGTH: 30 M SHIELDED	6ES7923-0CD00-0BA0

STEP 7 software

Quantity	Item	Order no.
1	STEP 7 Software version 5.2 or later, installed on the programming device.	6ES7810-4CC06-0YX0

You can use the following resistance-based sensors and voltage measuring transducers to detect the analog signals:

Resistance-based sensors and voltage measuring transducers

Quantity	Item	Order no.
1	±5V voltage measuring transducer	depends on the manufacturer
3	PT100 Standard	depends on the manufacturer

2.1 Basics

# Note

"Getting Started" only describes the handling of PT100 standard voltage measuring transducers and resistance thermometers. If you wish to use other transducers, you will need to wire and configure an SM331 differently.

The following tools and materials will also be needed:

General tools and materials

Quantity	y Item Order no.	
Various	M6 bolts and nuts (length depends on the mounting position) commonly available	
1	Screwdriver with 3.5 mm blade	commonly available
1	Screwdriver with 4.5 mm blade	commonly available
1	Side cutter and cable stripper	commonly available
1	Crimp tool commonly available	
X m	Cable for grounding the mounting rail with 10 mm <sup>2</sup> cross- section, ring terminal with 6.5 mm hole, length appropriate for local requirements.	
Xm	Flexible wire with 1mm <sup>2</sup> diameter with fitting wire end sleeves, form A in 3 different colors – blue, red, and green         commonly available	
Xm	3-wire power cord (AC 230/120V) with protective contact commonly available socket, length according to local conditions	
1	Calibration device (measuring instrument for commissioning, which can measure and supply current)depends on the manufacturer	

Prerequisites

2.1 Basics

# Task

# 3.1 Example of an application

## Overview

The Getting Started manual leads you all the way through an example application during which you will connect the following four sensors:

- A pressure sensor, which is connected to a voltage measuring transducer (±5V).
- Three resistance thermometers, type PT100

They will initiate fault diagnostics and hardware interrupts. Analog input module SM331, AI8x12 Bit (order number 6ES7 331-7KF02-0AB0) is available to you.

The module can initiate diagnostic alarms and hardware interrupts. It can process up to 8 analog inputs. Various types of measurements can be set for each module (e.g. current measurements, a voltage measurement, PT 100, thermocouple).

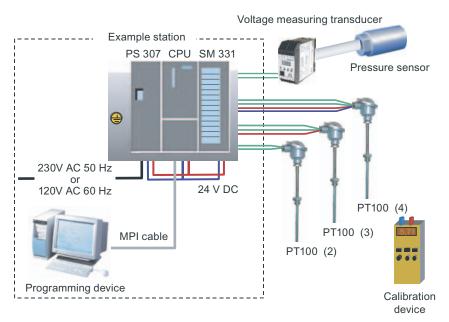


Figure 3-1 Components of the example station

Task

3.1 Example of an application

# In the following sections you will be introduced to:

- Mechanical setup of the example station
  - General mounting instructions for S7-300 modules
  - Configuration of the SM331 for the two selected measurement transducer types
- Electrical connection of the example station
  - Wiring the power supply module and the CPU
  - Connecting the analog module in the conventional manner
  - Connecting the analog module using the SIMATIC TOP connect system cabling
- Configuration of the SIMATIC Manager
  - Using the project wizard
  - Completing the automatically generated hardware configuration
  - Integrating the supplied user program source
- Testing the user program
  - Interpreting the read values
  - Converting the measured values into readable analog values
- Utilizing the diagnostic capabilities of the SM331 module
  - Triggering a diagnostic interrupt
  - Evaluating the diagnostics:
- Application of hardware interrupts
  - Configuration of hardware interrupts
  - Configuration and analysis of hardware interrupts

# See also

Assembling the example station (Page 4-1) Wiring the power supply and the CPU (Page 5-1) Create a new project (Page 6-1) Downloading the system data and user program (Page 7-1) Initiating the diagnostic interrupt (Page 8-1) Hardware interrupt (Page 9-1)

# Mechanical setup of the example station

# 4.1 Assembling the example station

#### Overview

The setup of the example station is divided into two steps. First, the setup of the power supply and the CPU is explained. After you become acquainted with analog module SM331, the mounting of it is described.

# Prerequisites

Before you can use analog input module SM331, you need a basic setup of general SIMATIC S7-300 components.

The order of the assembly takes place from left to right:

- Power supply PS307
- CPU 315-2 DP
- Analog module SM331

# Mechanical setup of the example station

4.1 Assembling the example station

# Instructions (without SM331)

Step	Graphic	Description
1		Screw on the mounting rail (screw size: M6) so that at least 40 mm space remains above and below the rail. When mounting it on a grounded metallic panel or on a grounded device mounting panel made of steel sheet, make sure you have a low impedance connection between the mounting rail and the mounting surface. Connect the rail to the protective conductor. An M6 screw is provided on the rail for this purpose.
2		<ul> <li>Mounting the power supply: :</li> <li>Hang the power supply on to the top end of the rail</li> <li>Screw it tight to the rail underneath</li> </ul>

4.2 Mounting of the analog module

Step	Graphic	Description
3		Connect the bus connector (delivered with the SM331) to the <b>left</b> connector on the back of the CPU
4		<ul> <li>Mounting the CPU: :</li> <li>Hang the CPU on to the top end of the rail</li> <li>Push it all the way left to the power supply</li> <li>Push it down</li> <li>Screw it tight to the rail underneath</li> </ul>

# 4.2 Mounting of the analog module

# 4.2.1 General information

# Overview

Prior to mounting the SM331, you must connect the measuring range modules accordingly. In this section, you will learn about:

- The components you need
- The properties of the analog input module
- What a measuring range module is and how it is configured
- Mounting a configured module

# See also

Measuring range modules (Page 4-7)

4.2 Mounting of the analog module

# 4.2.2 Components of the SM331 with conventional connecting plug

# Overview

A functional analog module consists of the following components:

- Module SM331 (in our example 6ES7331-7KF02-0AB0)
- 20-pin front connector There are two different types of front connectors:
  - With spring clamp (order number 6ES7392-1BJ00-0AA0)
  - With screw contacts (order number 6ES7392-1AJ00-0AA0)

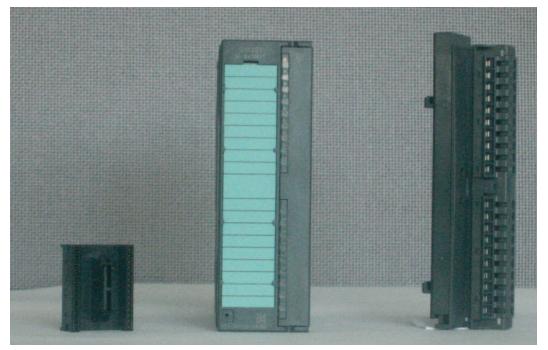


Figure 4-1 Components of the SM331

# 4.2.3 SM331 with the SIMATIC TOP connect system cabling

# Overview

The SIMATIC TOP connect system cables for the SM331 module consist of the following components

- Front connector module (order number 6ES7921-3AF00-0AA0)
- Terminal block TPA (order number 6ES7924-0CC00-0AB0)
- Various small components



Figure 4-2 Components of the SM331 with the SIMATIC TOP connect system cables

# See also

Basics (Page 2-1)

4.2 Mounting of the analog module

# 4.2.4 Features of the analog module

# Features

The module is a universal analog module that can be used with the most commonly used applications.

The desired measuring mode should be set up directly on the module with the measuring range modules.

- 8 inputs in 4 channel groups (each group with two inputs of same type)
- Measurement resolution adjustable for each channel group
- User-defined measuring mode per channel group:
  - Voltage
  - Current
  - Resistor
  - Temperature
- Programmable diagnostic interrupt
- Two channels with limit alarms (only channel 0 and channel 2 are configurable)
- Electrically isolated against backplane bus connection
- Electrically isolated against load voltage (exception: at least one measuring range module is set to position D)

# Scope of supply of module SM331 (order no.: 6ES7331-7KF02-0AB0):

Components
Analog module SM331
Labeling strips
Bus connectors
2 cable ties (not in the picture above) to mount the external wiring

## See also

Measuring range modules (Page 4-7)

# 4.2.5 Measuring range modules

# Connection

Module SM331 has 4 measuring range modules (one measuring range module per channel group). You can plug each measuring range module into 4 different positions (A, B, C, or D). The position enables you to specify the transducer to be connected to the respective channel group.

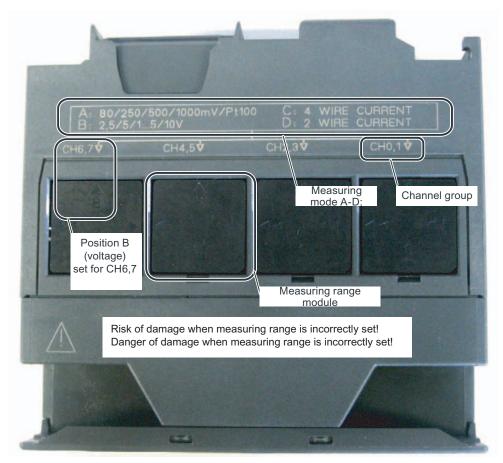


Figure 4-3 4 measuring range modules with default setting B (voltage)

Positions of the measuring range modules

Position	Type of measurement	
A	Thermocouple / resistance measurement	
В	Voltage (factory setting)	
С	Current (4-wire transducer)	
D	Current (2-wire transducer)	

# 4.2 Mounting of the analog module

In our example task, a sensor with a  $\pm 5V$  voltage measuring transducer is connected to channel group CH0,1 at input 0.

For connecting the three type PT100 resistance thermometers, you need a complete channel group (CH2,3/CH4,5/CH6,7) for each PT100.

The first measuring range module of channel group CH0,1 therefore contains position B (default setting). You must switch the other modules to position A.

Positioning of the measuring range modules

Step	Graphic	Description
1		Using a screwdriver, remove the two measuring range modules
2		Turn the measuring range modules to the desired position:
3	C 4 WIRE CURRENT CH2 WIRE CURRENT CH2 VIRE CUR	Plug the measuring range modules back into the module In our example, the modules should have the following positions: CH0,1: B CH2,3: A CH4,5: A CH4,5: A CH6,7: A

# 4.2.6 Mounting the SM331 module

# Mounting the SM331

After you have prepared the analog module accordingly, mount it to the rail as well. Mounting the SM331 module

Step	Graphic	Description
1		<ul> <li>Mounting the SM331:</li> <li>Hang the SM331 to the top end of the rail</li> <li>Push it all the way to the left up to the CPU</li> <li>Push it down</li> <li>Screw it tight to the rail underneath</li> </ul>
2	SERVENS	<ul> <li>Mounting the front connector:</li> <li>Press the upper front connector button.</li> <li>Insert the connector into the module until the connector button snaps into the top position.</li> </ul>
3		<ul> <li>Mounting the shielded plate:</li> <li>Tighten the shielded plate to the underside of the mounting rail.</li> <li>Connect the two shielded connection terminals to the shielded plate.</li> </ul>

4.2 Mounting of the analog module

# 4.2.7 Mounting the TOP connect terminal block

# Procedure

The TOP connect system cables need a system-specific terminal block.

Step	Graphic	a system-specific terminal block. Description	
1		Connect the terminal block to the shielded support element.	
2		Latch the terminal block with the shielded support element onto a top-hat rail.	
3		Install the shielded element terminals onto the shielded support element.	

The example station is now mechanically mounted.

# 5

# **Electric connection**

# 5.1 Wiring the power supply and the CPU

Overview



# Warning

You might get an electrical shock if power supply module PS307 is turned on or the power cord is connected to the main power supply. Always switch off power before you start wiring the S7-300.



Figure 5-1 Wiring the power supply and the CPU

5.1 Wiring the power supply and the CPU

The example station requires a power supply. The wiring is done as follows: Wiring the power supply and the CPU

Step	Graphic	Description
1		Open the front panel covers of the power supply module and CPU.
2		Unscrew the strain relief clamp on the power supply module.
3		Remove the insulation from the power cord, attach the cable end sleeves (for stranded conductors), and connect them to the power supply.
4	A F	Screw the strain relief clamp in place.
5		<ul> <li>Insert the power supply jumper between the power supply and the CPU and tighten it securely.</li> <li>Info on the grounding slide switch of the CPU:</li> <li>Insert: non-isolated (as-delivered state)</li> <li>Remove: Isolated</li> <li>You do not have to change the grounding slide switch of the CPU, because the SM331 is already isolated.</li> </ul>
6	VOLTAGE SELECTOR	Check that the line voltage selector switch is set to the correct line voltage. The default line voltage setting for the power supply module is 230 VAC. To change the setting, proceed as follows: Remove the protective cap using a screwdriver, set the switch to the existing main power supply, and re-insert the protective cap.

# 5.2.1 Shielded lines for analog signals

#### General information

The wiring of analog module SM331 is independent of the type of the analog measuring transducer.

#### Cables

You should use shielded and twisted-pair lines for analog signals. This reduces the effect of interference. You should ground the shield of the analog lines at both ends of the line.

If there are differences in potential between the ends of the cables, equipotential current may flow across the shield, which could disturb the analog signals. In this case, the shield should only be grounded at one end of the line or an adequately dimensioned equipotential bonding conductor should be routed.

# 5.2.2 Voltage measuring transducer wiring principle

# Wiring the voltage measuring transducer:

A voltage measuring transducer should be wired as follows:

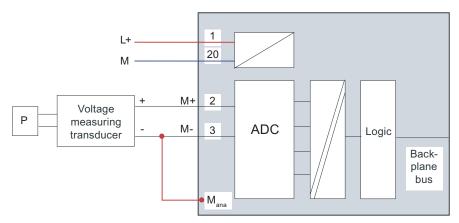


Figure 5-2 Wiring principle: Voltage measuring transducer for an isolated SM331

If you use the SM331 module in areas of heavy EMC interference, you should connect M- to  $M_{ana}$ . In this way, the potential difference between the inputs and the  $M_{ana}$  reference potential will not exceed the permitted value.

# 5.2.3 Wiring principle of the resistance thermometer (PT100)

## Options

There are three options for wiring the resistance thermometer:

- Four-wire connection
- Three-wire connection
- Two-wire connection

For a 4-wire and 3-wire connection, the module provides a constant current via terminals Ic+ and Ic-, which compensates for the voltage drop of the measuring lines.

It is imperative at this point to wire the constant current cables directly to the resistance thermometer.

## Note

Compensated measurements with 3- or 4-wire elements return a more precise result than that of 2-wire measurements.

## 4-Wire Connection of a Resistance Thermometer

The voltage arising at the resistance thermometer is measured at connections M + and M -.

When connecting, observe the polarity of the connected lines Ic+ / M+ and Ic- / M- and ensure that the lines are connected directly to the resistance thermometer.

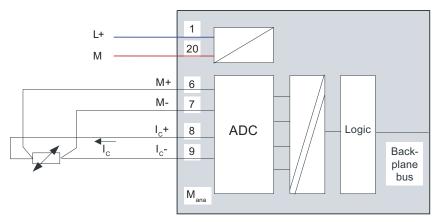


Figure 5-3 Wiring: 4-Wire Connection of a Resistance Thermometer

# 3-Wire Connection of a Resistance Thermometer

For a 3-wire connection, you must generally place a jumper between M- and Ic-.

When connecting, ensure that connected lines Ic+ and M+ are connected directly to the resistance thermometer.

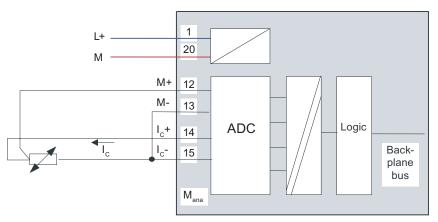


Figure 5-4 Wiring: 3-Wire Connection of a Resistance Thermometer

# 2-Wire Connection of a Resistance Thermometer

For a 2-wire connection, you must insert a jumper between terminals M+ and Ic+ on the front connector of the module and another jumper between terminals M- and Ic-.

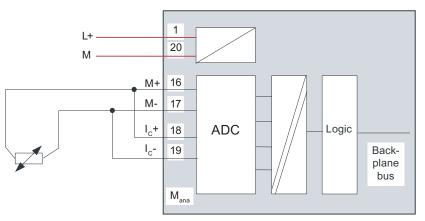


Figure 5-5 Wiring: 2-Wire Connection of a Resistance Thermometer

# 5.2.4 Connecting the analog module in the conventional manner

## **General information**

This section encompasses the wiring of the analog modules to individual lines in the conventional manner. The type of connection using TOP connect system cables can be found in the corresponding section.

# Tasks

The wiring of the analog module consists of the following tasks:

- Connecting the power supply (red cable)
- Connecting the voltage measuring transducer (green cable)
- Connecting the unused channel of a channel group in parallel
- Wiring of the first PT100 with a 4-wire connection (green cable)
- Wiring of the first PT100 with a 3-wire connection (green cable)
- Wiring of the first PT100 with a 3-wire connection (green cable)
- Wiring the ground (blue cable)

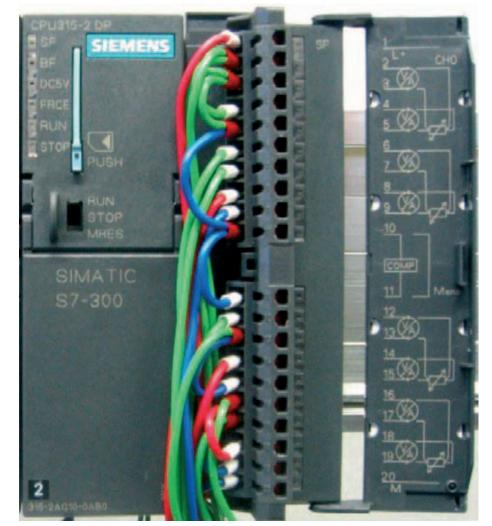


Figure 5-6 SM331 Front connector wiring

# Procedure

The required wiring tasks are explained below step-by-step:

SM331 Front connector wiring

Step	Graphic	wiring	Comments
1		Open the front door of the SM331	The terminals are printed on the front door
2		Remove 6 mm of the insulation from the ends of the wires that go into the front connector. Attach cable end sleeves to these ends.	
3		Wire the front connector as follows: Terminal 1: L+	Power supply of the module
4	<u>Ç</u>	Terminal 2: M+ sensor 1 Terminal 3: M- sensor 1 Connect inputs in parallel: Connect terminal 2 to 4 Connect terminal 3 to 5	Standard wiring for voltage measuring transducers to an isolated module To maintain the diagnostic functionality of channel group 0, you must connect the second unused input to the first in parallel
5		Terminal 6: M+ PT100 (4-wire) Terminal 7: M- PT100 (4-wire) Terminal 8: Ic+ PT100 (4-wire) Terminal 9: Ic- PT100 (4-wire)	Standard wiring of a PT100 with a 4-wire connection
6		Connect terminal 10 (Comp) to Mana Connect terminal 11 (Mana) to terminals 3 and 5	Comp is not used for voltage measuring and PT100 Recommended for voltage measuring transducers
7		Terminal 12: M+ PT100 (3-wire) Terminal 13: M PT100 (3-wire) Terminal 14: PT100 (3-wire) Connect terminal 15 (Ic-) to 13 (M-)	Standard wiring of a PT100 with a 3-wire connection
8	K,	Terminal 16: M+ PT100 (2-wire) Terminal 17: M PT100 (2-wire) Connect terminal 18 (Ic+) to 16 M+ Connect terminal 19 (Ic-) to 17 (M-)	Standard wiring of a PT100 with a 2-wire connection
9	12	Terminal 20: G	Ground

# See also

Wiring the analog module using the system cables of TOP connect (Page 5-10) Measuring range modules (Page 4-7)

# 5.2.5 Wiring the connection terminals

#### Overview

In our example, a terminal strip replaces the connections of the voltage sensor or of the resistance thermometer. The voltages are specified using a calibration device; the resistance thermometer is simulated by a potentiometer.

#### Voltage measurement

In our example, we are simulating the voltage measuring transducer via the following connection:

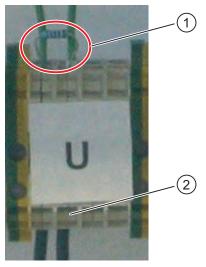


Figure 5-7 Terminal connection of the voltage measuring transducer

- (1) 750 Ohms resistance
- (2) Calibration device terminal for specifying the voltage

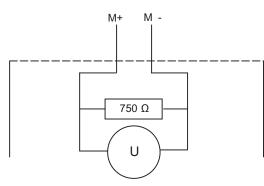


Figure 5-8 Block diagram of the voltage measuring transducer

The type of protective circuit required for your voltage measuring transducer can be found in the manual for your voltage sensor.

# PT100 resistance thermometers

If you want to connect a PT100, then you must also wire the terminals to the

resistance thermometers as explained in the corresponding section.

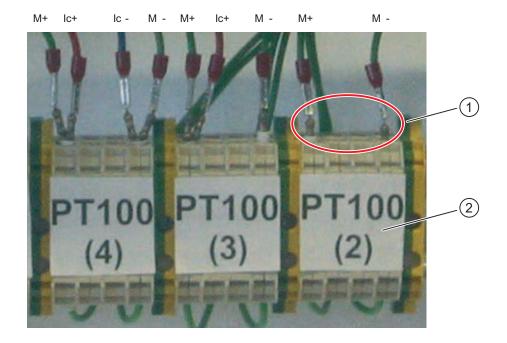
In our example station, a terminal strip replaces the terminals of the resistance thermometer. The desired resistance value is set using a potentiometer.

To simulate the lines, we use resistors. The 5 Ohm resistor simulates a copper wire with a cross-section of 0.6 mm2 and a length of 171.4 m.

Using the following formula, the length of the conductor is calculated from the resistance:

 $R = (\rho *I):q$  $I = (R*q):\rho$ 

- R: Line resistance
- $\rho$ : Specific resistance of the conductor material (copper, 0.0178 $\Omega$  mm<sup>2</sup>/m)
- q: Conductor cross-section
- I: Conductor length



Terminal connection of the PT100

- (1) 5-Ohm resistors for simulating the conductor length
- (2) PT100 simulated

#### See also

Wiring principle of the resistance thermometer (PT100) (Page 5-4)

SM331;AI 8x12 Bit Getting Started Part 2: Voltage and PT100 Getting Started, 11/2006, A5E00264161-02

# 5.2.6 Wiring the analog module using the system cables of TOP connect

# Overview

Using the SIMATIC TOP connect system cables, route the sensor-specific wiring from the analog module to the TOP connect terminal block.

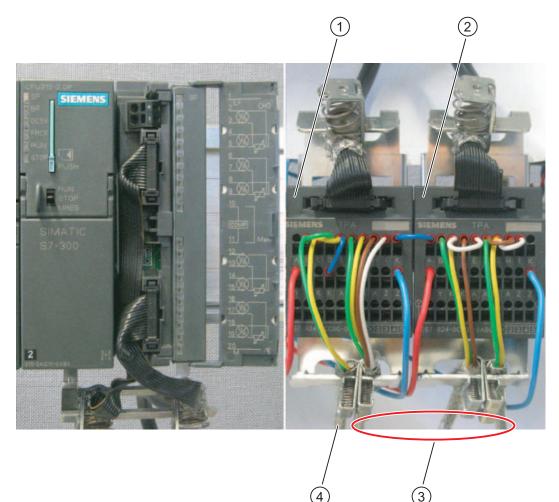


Figure 5-9 TOP connect connection

- (1) Terminal block 1
- (2) Terminal block 2
- (3) For resistance thermometer PT 100
- (4) For the voltage measuring transducer

The following table describes the individual tasks of the wiring for the connection to terminal block 1 step-by-step. The connection of terminal block 2 is done in the same manner.

# SM331 Front connector wiring

Step	Graphic	wiring
1		Strip the protective jacket from the Top connect flat round cable to the appropriate length and expose the 16-pin flat ribbon cable. Shorten the shielded cable to approx. 15 mm and turn it up and back. Insert the flat round cable into the shielded connection terminal.
2		Guide the exposed flat ribbon cable into the snap-on/screw- on connector and press on it lightly. Make sure that the identification triangle of the plug (green circle) and the wire marked in yellow are on the same side.
3		Now plug the 16-pin flat connector into the front connector of the analog module. (1) If you need more than 4A current (this is not the case in our example), you must establish the power supply of the module directly via the terminals of the front connector of the SM331 (see red circle). Cabling to terminal block 1
4	SIEMENS TPA	Plug the other end of the flat round cable into the terminal block

Wiring the SM331	TOP connect terminals
------------------	-----------------------

Step	Graphic	wiring	Comments
1	0	<b>Terminal block 1 and 2:</b> Terminal Y: Power supply of the module	For a requirement of up to 4A of current, the power supply of the module can be routed across the terminal blocks. For higher requirements of current, the power supply must be directly connected to the front connector of the module.
2	ſ	<b>Terminal block 1:</b> Terminal B: M+ Voltage Transducer Terminal C: M- Voltage Transducer Connect terminals E and K Connect inputs in parallel: Connect terminal B to D Connect terminal C to E	Standard wiring for voltage measuring transducers on an isolated module To maintain the diagnostic functionality of channel group 0, you must connect the second unused input to the first in parallel
3		<b>Terminal block 1:</b> Terminal F: M+ PT100 (4-wire) Terminal G: M- PT100 (4-wire) Terminal H: Ic+ PT100 (4-wire) Terminal I: Ic+ PT100 (4-wire)	Standard wiring of a PT100 with a 4- wire connection
4		<b>Terminal block 1:</b> Connect terminal K Comp to A Mana	Comp is not used for voltage measuring and PT100 Recommended for voltage measuring transducers
5	r	<b>Terminal block 2:</b> Terminal B: M+ PT100 (3-wire) Terminal C: M- PT100 (3-wire) Terminal D: Ic+ PT100 (3-wire) Terminal E: Connect Ic- to terminal C M-	Standard wiring of a PT100 with a 3- wire connection
6	r	<b>Terminal block 2:</b> Terminal F: M+ PT100 (2-wire) Terminal G: M- PT100 (2-wire) Terminal H: Connect Ic+ to F M+ Terminal I: Connect Ic to G M-	Standard wiring of a PT100 with a 2- wire connection
7		<b>Terminal block 2:</b> Terminal Z: M	Grounding terminal

#### Note

If you need electrical isolation between the CPU and the analog module, you must supply the analog module with a separate power supply.

# 5.2.7 Wiring of a PT100

#### wiring

The figure clarifies the connection of a PT100 with a 4-wire connection. The cables are wired together inside the PT100 itself.



Figure 5-10 Wiring of the PT100 with a 4-wire connection

# 5.2.8 Checking the wiring

# Procedure

If you want to test your wiring, switch the power supply on. Do not forget to set the CPU to STOP (see the red circle).



Figure 5-11 Successful wiring, CPU in STOP position

If a red LED is lit, an error has occurred in the wiring. Verify your wiring..

# **Configuration of the SIMATIC Manager**

6.1 Creating a new STEP 7 project

### 6.1.1 Create a new project

### "New Project..." wizard

Use SIMATIC Manager STEP7 V5.2 or later for configuring the new CPU 315-2 DP.

Start the SIMATIC Manager by clicking the "SIMATIC Manager" icon on your Windows Desktop and create a new project with the "New Project" wizard.

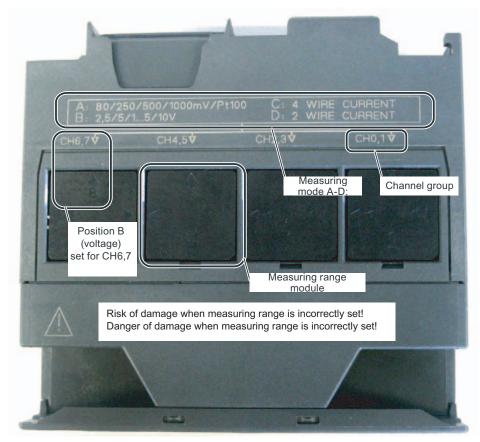


Figure 6-1 Starting the "New Project..." wizard

SM331;AI 8x12 Bit Getting Started Part 2: Voltage and PT100 Getting Started, 11/2006, A5E00264161-02

### 6.1 Creating a new STEP 7 project

A project wizard introduction window will appear. The wizard guides you through the procedure for creating a project.

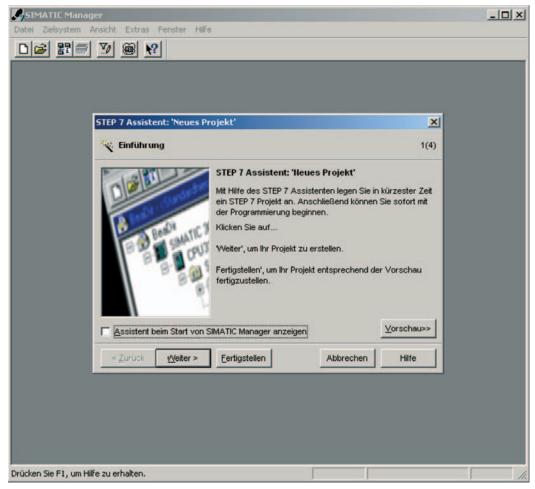


Figure 6-2 "New Project" wizard, start

The following must be specified during the creation procedure:

- The CPU type
- The basic user program
- The organization blocks
- Project name

Click "Next."

## 6.1.2 CPU selection

### Procedure

Choose CPU 315-2DP for the example project. (You can also use our example for a different CPU. Then select the corresponding CPU.)

CP <u>U</u> :	CPU Type	Order No	
	CPU314C-2DP	6ES7 314-6CF00-0AB0	
	CPU314C-2PtP	6ES7 314-68F00-0AB0	
	CPU315	6ES7 315-1AF03-0AB0	
	CPU315-2DP	6ES7 315-2AG10-0AB0	
	CPU316-2 DP	6ES7 316-2AG00-0AB0	-
		6ES7 318 3A IOO OABO	100
<u>C</u> PU name:	CPU315-2DP(1)		
MPI <u>a</u> ddress:		k memory 128 KB; 0.1 ms/1000 ructions; MPI+ DP connection (DP	-

Figure 6-3 "New Project" wizard: selecting a CPU

Click "Next".

6.1 Creating a new STEP 7 project

## 6.1.3 Defining the basic user program

## Procedure

Choose the configuring language STL and select the following organization blocks (OBs):

- OB1 cyclically executed block
- OB40 hardware interrupt
- OB82 diagnostic interrupt

OB1 is required in every project and is called up cyclically.

OB40 is called up when a hardware interrupt occurs.

OB 82 is called up when a diagnostic interrupt occurs.

Bloc <u>k</u> s:	Block Name	Symbolic Name	
	<ul> <li>○ OB38</li> <li>○ OB40</li> <li>○ OB41</li> <li>○ OB42</li> <li>○ OB43</li> </ul>	Cyclic Interrupt 8 Hardware Interrupt 0 Hardware Interrupt 1 Hardware Interrupt 2 Hardware Interrupt 3	
	Select <u>A</u> ll		Help on <u>O</u> B
	Language for Se	elected Blocks	A CASE ALCON
	€ SIL	C LAD	C EBD
Create with source files			Previe <u>w</u> >>

Figure 6-4 "New Project" wizard: Inserting organization blocks

Click "Next."

## 6.1.4 Assigning the project name

### Procedure

Select the "Project name" text box and overwrite the existing name in it with "Getting Started S7 SM331".

Project name:	Getting Started S7-SM331				
Existing projects:	Sample2 Sample3 Sample4	,			

Figure 6-5 "New Project" wizard: Naming the project name

Click "Finish". The basic STEP7 project is created automatically.

6.1 Creating a new STEP 7 project

## 6.1.5 Result S7 project is created

## Result

The wizard has created the "Getting Started S7-SM331" project. You can see the inserted organization blocks in the right window.

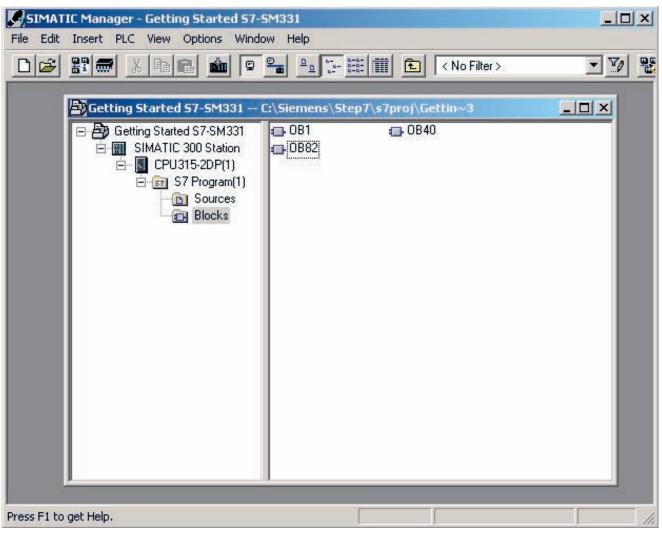


Figure 6-6 "New Project" wizard results

## 6.2.1 Creating the hardware configuration

### Requirement

The STEP 7 wizard has created a basic S7 project. You also need complete hardware configuration in order to create the system data for the CPU.

### Procedure

You can create the hardware configuration of the example station with SIMATIC Manager. . To do this, select the "SIMATIC 300 Station" folder in the left window. Start the hardware configuration by double clicking the "Hardware" folder in the right window.

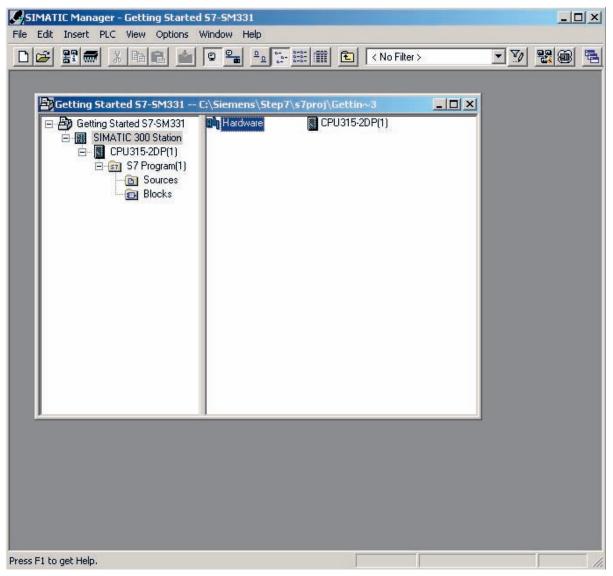


Figure 6-7 Calling up the hardware configuration

## 6.2.2 Adding SIMATIC components

### Procedure

First select a power supply module from the hardware catalog.

If the hardware catalog is not visible, open it with the shortcut key combination Ctrl+K or by clicking the catalog icon (blue arrow).

In the hardware catalog you can browse through the SIMATIC 300 folder to the PS-300 folder.

HW Config - [SIMATIC 300-Station (Configuration) -- G55M331T2D] \_ 🗆 🗡 💵 Station Edit Insert PLC View Options Window Help \_ 8 × 🚵 🏜 📳 🗖 🚼 🕺 \* Profile Standard 🗃 (0) UR • 1 . CPU315-2DP(1) 2 🖕 🧰 PS-300 X2 PS 307 10A PS 307 2A PS 307 5A 🛾 DP 4 5 🚊 🚞 Al-300 8 SM 331 Al2x12Bit 9 SM 331 Al2x12Bit SM 331 AI2x12Bit SM 331 Al2x12Bit SM 331 AI2x12Bit SM 331 Al4x0/4 to 20mA, Ex SM 331 Al8x12Bit SM 331 Al8x12Bit SM 331 Al8x12Bit SM 331 Al8x13Bit ١ • SM 331 Al8x13Bit SM 331 Al8x14Bit 🗲 🔿 (0) UR SM 331 Al8x16Bit SM 331 Al8x16Bit Slot 🚺 Module MPI address Order number Firmware I address Q address Com. SM 331 AI8xRTD ٠ SM 331 AI8xTC <u>X2</u> DF 3 CPU315-2DP(1) 6ES7 315-2AG10-0AB0 ¥2.0 2 SM 331 Al8xTC/4xRTD, Ex 204F -6ES7 307-1EA00-0AA0 Load supply voltage 120 / 230 VAC:24 VDC / 5 A ₹<u><</u> 4 5 Ŧ Chg // Press F1 to get Help.

Select PS307 5A and drag it into slot 1 (see red arrow).

Figure 6-8 Hardware configuration: Basic configuration

Result: PS 307 5A appears in the configuration of your rack.

## Inserting an analog module

There are many SM331 analog modules. For this project we use an SM331, Al8x12 bit with order number 6ES7 331-7KF02-0AB0.

The order number is displayed at the bottom of the hardware catalog (see blue arrow).

In the right window, click on the SM331 Al8x12Bit and drag it to the first free field in slot 4 (see red arrow) in the configuration table.

Now you have inserted all the modules into the hardware configuration. In the next step, you configure the module.

Result: You can now configure the SM331.

🖳 HW Config - [SIMATIC 300-Station (Configuration) GSS	M331T2D]						
📲 Station Edit Insert PLC View Options Window Help						_ 6	×
	<b>11</b>						
(0) UR					<b>_</b>	Profile Standard	•
1     PS 307 5A       2     CPU315-2DP(1)       3     4       4     Al8x12Bit       5     6       7     -					_	➡         ■	*
					F	- SM 331 Al8x13Bit - SM 331 Al8x14Bit	
(0) UR						SM 331 Al8x16Bit SM 331 Al8x16Bit	
Slot 🚺 Module Order number	Firmware	MPI address	l address	Q address	Com	- 🚺 SM 331 Al8xRTD	
1 PS 307 5A 6ES7 307-1EA00-0AA0	142.0				<b></b>	SM 331 Al8xTC	
2 CPU315-2DP(1) 6ES7 315-2AG10-0AB0	V2.0	2	2047*			SM 331 Al8xTC/4xRTD, Ex	-
			2041	-	<u> </u>	6ES7 331-7KF02-0AB0	₹≤
4 Al8x12Bit 6ES7 331-7KF02-0AB0			256271			Analog input module AI8/12 to 14 bits	<u> </u>
5							
Insertion possible						j Che	

Figure 6-9 Hardware configuration: Inserting SM331

## 6.2.3 Configuring the analog module

### Overview

The SIMATIC Manager inserts the analog module with the default settings. You can now modify the parameters to change the sensor types, diagnostics, and interrupt capabilities.

### Functionalities of the example station

The table shows which parameters have to be set for our example station.

SM331 functions of the example station

Functionalities	Description
Process reactions	Diagnostics – enabled
	Hardware interrupt when limit value exceeded - enabled
Sensor 1	Voltage measuring transducer
	Group diagnostics
	Measuring range ±5V
	<ul> <li>Limit values -3 Volts and +3 Volts</li> </ul>
Sensor 2	PT100 resistance thermometers
	Group diagnostics
	Check for wire break
	<ul> <li>Limit values -20 °C and +50 °C</li> </ul>
Sensor 3	PT100 resistance thermometers
	Group diagnostics
	Check for wire break
Sensor 4	PT100 resistance thermometers
	Group diagnostics
	Check for wire break

### Calling up the configuration

Double-click on slot 4 that has the SM331 in it. Select the "Inputs" tab.

Configure the following functions:

- Diagnostic interrupt enabled
- Hardware interrupt enabled
- Input 0-1:
  - Type of measurement: U
  - Measuring range ±5
  - Group diagnostics enabled
- Input 2-3, 4-5, and 6-7
  - Type of measurement: RT
  - Measuring range PT100 standard
  - Group diagnostics enabled
  - Wire break enabled
- Interference frequency
  - Select your power frequency (50 Hz or 60 Hz)
- Trigger for hardware interrupt channel 0
  - Upper limit value +3 V
  - Lower limit value -3V
- Trigger for hardware interrupt channel 2
  - Upper limit value +50 °C
  - Lower limit value -20 °C

Enable				
🔽 Diagnostic Interrupt 🛛 🔽	Hardware Interr	upt When Limit B	xceeded	
Input	0-1	2-3	4 - 5	6.7
Diagnostics				
Group Diagnostics:				
with Check for Wire Break:	Г			
Measuring				
Measuring Type:	E	RT	RT	RT
Measuring Range:	+/-5V	Pt 100 Std.	Pt 100 Std.	Pt 100 Std.
Position of Measuring Range Selection Module:	[B]	[A]	[A]	[A]
interference frequency	50 Hz	50 Hz	50 Hz	50 Hz
Trigger for Hardware Interrupt	Channel 0	Channel 2		
High Limit:	3.000 V	50.0 °C		
Low Limit:	-3.000 V	-20.0 °C		

Figure 6-10 SM331: Configuration

### Explanation of the settings of the SM331

#### **Diagnostic interrupt:**

If the diagnostic interrupt is enabled, diagnostic OB86 is called up when the ground or the power supply is missing.

#### Hardware interrupt:

If the parameter "Hardware interrupt when limit value exceeded" is enabled, hardware interrupt OB40 is called up when the set limit value is exceeded or undershot.

You can configure the limit values in the same window under "hardware interrupt triggers".

#### Group diagnostics:

If group diagnostics is selected, channel-linked diagnostic messages are enabled. If a diagnostic event occurs, OB86 is called up.

#### Wire break check:

If wire break check is enabled, a wire breakage is diagnosed. Diagnostic OB86 is called up.

Type of measurement:

U stands for voltage.

RT stands for resistance (resistor, temperature).

#### Measuring range:

Specifying the measuring range of the voltage sensor and type PT100.

#### Position of the measuring range module:

The required setting of the measuring range module is displayed.

#### Interference frequency (Interference frequency suppression):

You set the interference frequency on your existing network frequency.

#### Hardware interrupt trigger:

If the parameter "hardware interrupt when limit is exceeded" is enabled, you can enter your required limit values. If a fixed value is exceeded or undershot, hardware interrupt OB40 is called up.

Only channels (inputs) 0 and 2 have hardware interrupt capabilities.

#### Finishing the hardware configuration:

Close the window with the configuration.

Compile and save the project with the command "Station > Save and Compile" (Ctrl+S).

This completes your hardware configuration for the project.

#### See also

Types of diagnostic messages (Page 8-4) Measuring range modules (Page 4-7)

## 6.2.4 Power-up test

### Procedure

For testing, do a power-up test and download the system data.

Step	Graphic	Description
1	Site ATLC Manager - G55413312D File: Edit. Insert PLC View Options Window Help New Depm Copen Copen Version I Project Close Multiproject S7.Memory Card File Save As Ctrl+S Debtec Debtec	Erase your Micro Memory Card with a Power PG or a PC with external programming device: In SIMATIC Manager, select "File -> S7 Memory Card > Delete". The MMC will be deleted.
2	SIEMENS SIEMENS PUSH RUN STOP KHES	Switch off the power supply to the CPU Insert the MMC into the CPU. Switch on the power supply.
3	RUN STOP WRES	If the CPU is in RUN mode, set it to STOP mode.
4		Switch the power supply back on. If the STOP LED flashes, the CPU is requesting a reset Acknowledge this by turning the mode switch to MRES for a moment.
5		Connect the CPU to the programming device using an MPI cable To do this, connect the MPI cable with the CPU's MPI port. Connect the other end to the programming device interface of your programming device.

Configuration of the SIMATIC Manager

6.2 Configuring the hardware configuration

## Downloading hardware configuration

Load the hardware configuration into the CPU with HW Config.

HW Config - [SIMATIC 300-Station	(Configuration) G55M331T2		_ D ×
Il Station Edit Insert PLC View O	ptions Window Help		_ 8 ×
D 🔊 🖙 🗣 🚇 🖻 🖻 🖻	🕯 🏟 🏦 🗖 🔡 🕅		
	Select Target Module	×	
(0) UR 1 PS 307 5A	Target modules:		
2 CPU315-2DP(1)	Module	Racks Slot	
<u>X2</u> DP 3	CPU315-2DP(1)	0 2	
4 Al8x12Bit			
5			
<u>6</u> 7			
	<u> </u>		
9	Select All		
<u>,</u>			
	OK	Cancel Help	
			-
Press F1 to get Help.			Chg //

Figure 6-11 Download the CPU hardware configuration (1)

### Configuration of the SIMATIC Manager

6.2 Configuring the hardware configuration

Click the "Load to module" icon (see the red circle).

When the dialog window "Select target module" appears, click OK (see the red arrow).

Select node address	
Over which station address is the programming device connected to the module CPU315-2DP(1)?	
Rack: 0 million Slot: 2 million	
Target Station: <ul> <li>Local</li> <li>Can be reached by means of gateway</li> <li></li></ul>	
Enter connection to target station:         MPI address       Module type       Station name       CPU name       Plant designation         2       CPU 315-2 DP	
Accessible Nodes	
View	Download  Station: SIMATIC 300-Station Module: [0/2/0] CPU315-2DP(1)
OK Cancel Help	Cancel

Figure 6-12 Download the CPU hardware configuration (2)

The dialog window "Select target address" will be shown. Click "OK." The system data will now be transferred to the CPU.

## Starting the CPU

Switch the CPU to RUN.

If you have performed the hardware configuration correctly, two green LEDs (RUN and DC5V) should be lit on the CPU.



Figure 6-13 CPU in error free state

If the RUN LED does not light up, there is an error.

Read out the diagnostic buffer using the programming device to localize the error. Possible causes of error:

- The wiring was not done correctly
- The coding cube is improperly plugged in
- You have incorrectly input the parameters of the SM331.

### 6.3.1 Tasks of the user program

#### Overview

The example user program

- stores sensor values in a data block and
- saves the status information regarding the hardware interrupts in a marker word.

The status information is acknowledged by means of a bit. Furthermore, the channel values (values of the input words) are saved in another data block.

The following tasks have to be performed in the user program:

- 1. Cyclical storage of the analog inputs in a data block (DB1)
- Cyclical conversion of the sensor values in floating point values (FC1) and storage in a data block (DB2)
- 3. Acknowledgement of the hardware interrupt status when the acknowledge marker (M200.0) is TRUE.
- 4. Save the status in a marker word (MW100) when a hardware interrupt occurs

Structure	of the	user	program
-----------	--------	------	---------

Call-up type	Responsible organization block	Task to be programmed	Used block or marker		
Cyclic execution	OB1	Save analog inputs	DB1		
		Convert and store the sensor values	FC1, DB2		
		Acknowledge hardware interrupt	M200.0		
Hardware interrupt triggered call-up	OB40	Save status	MW100		
Diagnostic interrupt triggered call-up	agnostic interrupt OB82				

#### OB82 diagnostic interrupt

In the STEP7 program, the OB82 is used for modules with diagnostic capabilities.

If the module detects an error (both for incoming and outgoing events), the module makes a diagnostic interrupt request to the CPU. The operating system then calls up OB 82.

In our example, we use OB82 merely to prevent the CPU from changing to STOP mode. You can program reactions to diagnostic interrupts in OB82.

## 6.3.2 Creating a user program

### Procedure

There are two ways to create a user program.

- If you know how to program STEP7 STL, then you can create and program the necessary blocks and functions in the blocks folder.
- You can insert the user program from an STL source into your project. We describe this method in the "Getting started" manual.

Creating a user program in STEP7 requires three steps:

- 1. Downloading the source file directly from the HTML page
- 2. Importing a source file
- 3. Compiling the source

### Downloading the source file

You can download the source file directly from the HTML page from which you loaded this "Getting Started" manual. Click on "Info" and the download window will open.

- Make note of the name of the source file.
- Save the source file to your hard drive.

## Importing a source file

You can import the source file into SIMATIC Manager as follows:

- Right click the "Sources" folder.
- Select "Insert new Object > External Source...".

SIMATIC Manager - GS	<b>7-5M331</b> w Options Window He	eln		<u>_0×</u>
			E < No Filter >	· 7/ 82
G\$7-5M331 C:\Proc G\$7-5M331 C:\Proc G\$7-5M331 	ram Files\Siemens\Ste ation P(1) ram(1) Cut Copy Paste Delete		tin~4	
	Insert New Object PLC Rename Object Properties Special Object Properties	F2 Alt+Return	STL Source SCL Source SCL Compile Control File GRAPH source External Source	
Inserts external source in the	current source folder.			

Figure 6-14 Importing an external source

In the "Insert external source" dialog, browse for the source file, which you have already downloaded and saved on your hard disk.

Insert extern	al source 🥂 🔀	1
Look in: ଢ	GHB 🔽 🕂 🖽 🕶	
GSSM331T	1SP.AWL	
1		
File name:	GSSM331T1SP.AWL Open	
Files of type:	Sources (*.awl;*.gr7;*.scl;*.inp;*.zg;*.sdg;*.sd 💌 Cancel	
		14

Figure 6-15 Importing an external source

Click "Open".

SIMATIC Manager has read the source file. In the right window you can see the source file inserted.

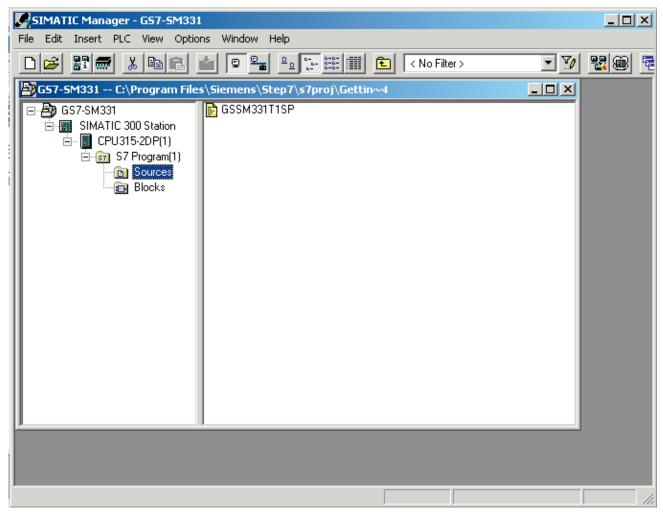


Figure 6-16 Storing the source file

### Compiling the source code

In order to create an executable STEP7 program, you must compile the STL source file.

Double-click on the source file in the source folder (see red arrow). The source code editor will be called up.

In the window of the source code editor you can view the source code.

🔣LAD/STL/FBD - [GSSM331T1SP GSSM331T2D\SIMATIC 300-Station\CPU315-2DP(1)]	×
👔 File Edit Insert PLC Debug View Options Window Help	×
DATA_BLOCK DB 1	
TITLE =Analogbaugruppe Kanäle Werte	
VERSION : 1.0	
STRUCT	
CH_0 : WORD ; //Kanal 0	
CH_1 : WORD ; //Kanal 1	
CH_2 : WORD ; //Kanal 2	

Figure 6-17 Source code editor

After the source code is loaded, start the compilation.

Press shortcut key combination Ctrl+K or select "File > Compile". The compilation will start immediately.

驖	AD/S	TL/FBD	- G59	M331T	l SP							
File	Edit	Insert	PLC	Debug	View	Options	Window	Help		,		
ſ	Vew								Ctrl+N		<b>N</b> ?	
	Open								Ctrl+O			
	Open O	NLINE							Ctrl+F3		_	
	Elose								Ctrl+F4			
2	Save								Ctrl+S			
2	5ave As	;										
F	Properti	ies										
		nd Upda		esses								
_		lonsisten	юу						Ctrl+Alt+K			
	Iompile								Ctrl+B			
	senerat	e Source	э						Ctrl+T			
	Print								Ctrl+P			
		eview										
	page Se	•										
F	Print Se	tup										
1	L GSSM	331T2D\;	SIMAT	IC 300-S	tation\(	EPU315-20	P(1)\\C	B82-Off				
		-				°\…\OB1-(						
		-		-		DP\\OB1						
	4 SR315	5alt\CPU:	315-20	P\CPU 3	15-2 DF	°\…\OB85	-Off					
	Exit								Alt+F4			
	END_D.	ATA_BL	OCK							-		
	DATA :	BLOCK	DB 2									
				rmerwe	rt (in	n mA)						
11	VERSI	ON : 1	.0									
Ш.	STR	ист										
Ш.		_1 : R	EAL	;								
Ш.		_2 : R										
		_3 : R		;								
		_STRUC			<i>c</i>							
Figur	gure 6-18 Compiling STL source files											

In the event of warning or error messages, check the source.

KAD/STL/FBD - [G55M331T15P G55M331T2D\SIMATIC 300-Station\CPU315-2DP(1)]	
🛐 File Edit Insert PLC Debug View Options Window Help 📃	B×
DATA_BLOCK DB 1	
TITLE =Analogbaugruppe Kanäle Werte VERSION : 1.0	
VERSION . I.O	
STRUCT CH 0 : WORD ; //Kanal 0	
CH 1 : WORD ; //Kanal 1	
CH_2 : WORD ; //Kanal 2	
CH_3 : WORD ; //Kanal 3	-
1	▶
Compile: GSSM331T2D\SIMATIC 300-Station\CPU315-2DP(1)\S7-Programm(1)\Quellen\GSSM331T	15 🔺
E Ln 000103 Col 018: Syntax error at 256.	
E Ln 000103 Col 021: Statement is waiting for addresses.	
E Ln 000106 Col 018: Syntax error at 258.	
E Ln 000106 Col 021: Statement is waiting for addresses.	الكح
	▶ Din
$\  \  \  \  \  \  \  \  \  \  \  \  \  \  \  \  \  \  \  $	6: Diaj
E Ln 000103 Col 018: Syntax error at 256. Offline Ln 5 Cn 1 Insert	ihg //

Figure 6-19 Source code editor, messages after compilation

Close the source editor.

After compiling the STL source without errors, the following blocks should appear in the block folder:

\_ 🗆 × SIMATIC Manager - G57-5M331 Insert PLC View File Edit Options Window Help 물 🛲 9 <u>D</u> B- 0-0-B- 0-0-2 Ê Ж ٦ ன் 9 Æ < No Filter > Ŧ ₽ 🖶 G57-SM331 -- C:\Program Files\Siemens\Step7\s7proj\Gettin~4 \_ 🗆 🗡 🖃 🎒 GS7-SM331 🚵 System Data 🕞 OB1 🖻 🎆 SIMATIC 300 Station 🔲 OB40 🔲 OB82 🗄 -- 🎆 CPU315-2DP(1) 🕞 FC1 🕞 DB1 🗄 💼 S7 Program(1) 🖪 DB2 Bources 💼 Blocks Press F1 to get Help.

OB1, OB40, OB82, FC1, DB1, and DB2

Figure 6-20 Generated blocks

### See also

Source code of the user program (Page A-1)

Configuration of the SIMATIC Manager

6.3 STEP 7 user program

-

# Testing the user program

## 7.1 Downloading the system data and user program

### Procedure

The hardware and software are now ready. The next step is to download the system data and the user program into the automation system. To do this, proceed as follows:

Downloading the system data and user program

Step	Graphic	Description
1	SIMATIC Manager - G57-SM331         File Edit Insert PLC View Options Window Help         Sime Sime Sime Sime Sime Sime Sime Sime	Using the SIMATIC Manager, download the user program and the system data (containing the hardware configuration) into the CPU.
2	SIEMENS PEW 286 PEW 26	Follow the instructions displayed on the screen. If all sensors are properly connected, the CPU and the SM331 do not display a red error light. The error-free operation of the CPU is displayed by the green "RUN" light.

7.1 Downloading the system data and user program

## Smart Label

The labeling strips for the modules were created with Siemens S7 Smart Label (order no: 2XV9 450-1SL01-0YX0).

A labeling strip in its actual size:

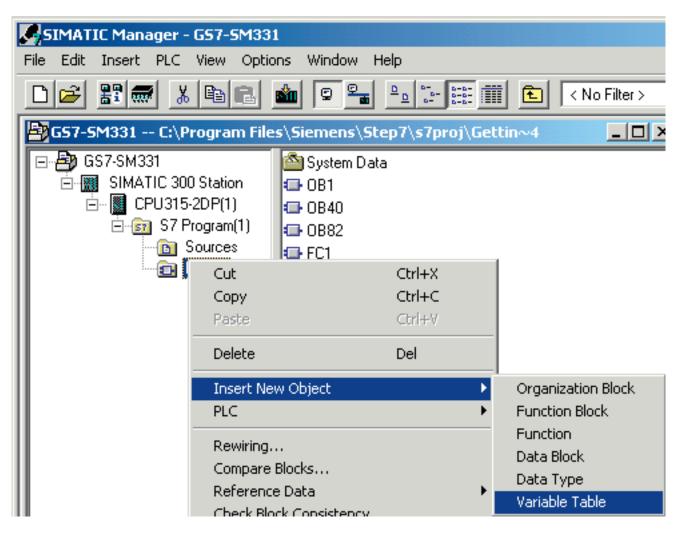
PEW 256
PEW 258
PEW 260
PEW 262
LA: PEW 256 S7- SmartLabel
PEW 264
PEW 266
PEW 268
PEW 270

Figure 7-1 S7-SmartLabel labeling strip for the example

### Procedure

In order to visualize the sensor values, insert a variable table as follows into the project. To do this, select from the context menu of the blocks folder:

Insert new object > Variable Table



K	Cor	ntrol_Displ	ay -	- GSSM	331T2D\SIMATIC	300-Station	CPU315-2D
		Address		Symbol	Display format	Status value	Modify value
1		// Channel	valu	ies	-		
2		DB1.DBW	0		HEX		
3		DB1.DBW	2		HEX		
4		DB1.DBW	4		HEX		
5		DB1.DBW	6		HEX		
6		DB1.DBW	8		HEX		
7		DB1.DBW	10		HEX		
8		DB1.DBW	12		HEX		
9		DB1.DBW	14		HEX		
10							
11		77 Analog v	/alue	s	~		
12		DB2.DBD	0		FLOATING_POINT		
13		DB2.DBD	4		FLOATING_POINT		
14		DB2.DBD	8		FLOATING_POINT		
15		DB2.DBD	12		FLOATING_POINT		
16		77 Process	cont	rol status	;		
17		M 200.0			BOOL		
18		MW 100			BIN		
19					0		

Complete the newly created variable table as follows: :

Figure 7-2 Variable table Control\_Display

(1) In this area you can monitor the channel values.

(2) In this area you can monitor and control the status signals.

(3) In this area you can see the analog values.

## Monitoring values

In order to monitor values, open the online view of the controller by clicking the eye glasses icon. Now you can monitor the values in the data blocks and markers.

🔛 🔽	ar - Control_Di	isplay 📄							
Table	Edit Insert	PLC Vari	able View Option:	s Window Help					
-F									
<b>%</b>									
8 C	ontrol_Displa	y @GS	5M331T2D\SIMAT	TC 300-Station\CPU31.	. <u>-   ×</u>				
	Address	Symbol	Display format	Status value	Modify				
1	// Channel va	alues							
2	DB1.DBW (	D	HEX	W#16#0000					
3	DB1.DBW 2	2	HEX	W#16#0000					
4	DB1.DBW 4	4	HEX	W#16#009C					
5	DB1.DBW 6	5	HEX	W#16#7FFF					
6	DB1.DBW 8	3	HEX	W#16#0114					
7	DB1.DBW 1	0	HEX	W#16#7FFF					
8	DB1.DBW 1	2	HEX	W#16#01AF					
9	DB1.DBW 1	4	HEX	W#16#7FFF					
10									
11	// Analog val	ues	^	•••••••••••••••••••••••••••••••••••••••					
12	DB2.DBD 0		FLOATING_POINT	0.0					
13	DB2.DBD 4		FLOATING_POINT	15.6					
14	DB2.DBD 8		FLOATING_POINT	27.6					
15	DB2.DBD 12	2	FLOATING_POINT	43.1					
16	// Process control status								
17	M 200.0		BOOL	📕 false					
18	MW 100	· · · · · · · · · · · · · · · · · · ·	BIN	2#0000_0000_0000_0	000				
19		]	0						
GSSM33	31T2D\SIMATIC	300-Statio	on\\S7-Programm(1	l) 🗌 <	🕩 RUN //				

Figure 7-3 Online view of the variable table

### Peculiarity in monitoring the values

While monitoring the values you will surely notice that the channel values are different from the analog values. The reason for this is that the analog module only supports the "Word" binary format (16 bits). Therefore, the values of the analog module have to be converted.

### **Controlling values**

To control the process acknowledgement, enter the desired value ("TRUE or FALSE", depending on whether you want to activate or deactivate acknowledgement) into the "Control Value" column and click the icon with the two arrows.

🔛 🖓 🗛 - Control_Display									
Table	Table Edit Insert PLC Variable View Options Window Help								
-[2]									
0									
		-							
	Control_Disp	lay			IC 300-Station\CPU315-20	<u>P ×</u>			
	Address			Display format	Status value	Modify value			
1	// Channel	valu	ies						
2	DB1.DBW	0		HEX	W#16#0000				
3	DB1.DBW	2		HEX	W#16#0000				
4	DB1.DBW	4		HEX	W#16#009C				
5	DB1.DBW	6		HEX	W#16#7FFF				
6	DB1.DBW	8		HEX	W#16#0114				
7	DB1.DBW	10		HEX	W#16#7FFF				
8	DB1.DBW	12		HEX	W#16#01AF				
9	DB1.DBW	14		HEX	W#16#7FFF				
10									
11	// Analog v	alue	s						
12	DB2.DBD	0		FLOATING_POINT	0.0				
13	DB2.DBD	4		FLOATING_POINT	15.6				
14	DB2.DBD	8		FLOATING_POINT	27.6				
15	DB2.DBD	12		FLOATING_POINT	43.1				
16	// Process (	cont	rol status						
17	M 200.0			BOOL	📕 false	true			
18	MW 100			BIN	2#0000_0000_0000_0000				
19									
GSSM	331T2D\SIMATI	(C 3)	00-Statio	n\\S7-Programm(1	l) 🗌 🔶	RUN //.			

Figure 7-4 Controlling variables

## 7.3 Analog value representation

## 7.3.1 Introduction

### Introduction

Analog input modules convert the analog process signal into a digital format (16-bit word). If you want to display analog process values, you must convert the digital values of the module into decimal values.

In our example program, the process value is displayed in the readable format, Volts (V), or in °C for the PT100. The conversion of the digital values into a decimal value is implemented by the programmed function in the FC1.

For converting from the digital value to the analog value, you must take five areas of application into consideration. These areas are described in the following tables.

## 7.3.2 Display of analog value of a ±5V voltage measuring transducer

Analog value representation		Voltage measuring range	Area of application	Remark	
Decimal	Hexadecim al				
32767	7FFF	5.926 V	Overflow	From the hex value 16#7F00 on, the sensor value	
32512	7F00			is above the overload range and is no longer valid.	
32511	7EFF	5.879 V	Overload range	This range corresponds to a tolerance band before	
27644	6C01			the overflow is reached. Within this measuring range, the resolution is no longer optimal	
27648	6C00	5 V	Nominal range	The nominal range is the normal range for	
20736	5100	3.75 V	]	recording measurement values. This range	
1	1	180.8µV		guarantees optimal resolution	
0	0	0V			
-1	FFFF				
-20736	AF00	-3.75 V			
-27648	9400	-5 V			
-27649	93FF		Undershoot range	Range corresponding to the overload range but for	
-32512	8100	-5.879V		low values	
-32513	80FF		Underflow	From hex value 16#80FF on, the sensor value is	
-32768	8000	-5.926V		below the configured measurement value range and is no longer valid.	

### Display of analog value of a ±5V voltage measuring transducer

With the aid of a voltage sensor (calibration device), you can now compare the specified values to the values in the analog value display in the table. The values will be identical.

7.3 Analog value representation

## 7.3.3 Display of analog value of a ±10V voltage measuring transducer

Analog value representation		Voltage measuring range	Area of application	Remark	
Decimal	Hexadecim al				
32767	7FFF	11.851V	Overflow	From the hex value 16#7F00 on, the sensor value	
32512	7F00			is above the overload range and is no longer valid.	
32511	7EFF	11.759V	Overload range	This range corresponds to a tolerance band before	
27644	6C01			the overflow is reached. Within this measuring range, the resolution is no longer optimal	
27648	6C00	10V	Nominal range	The nominal range is the normal range for	
20736	5100	7.5V		recording measurement values. This range	
1	1	361.7µV		guarantees optimal resolution	
0	0	0V			
-1	FFFF				
-20736	AF00	-7.5V			
-27648	9400	-10 V			
-27649	93FF		Undershoot range	Range corresponding to the overload range but for	
-32512	8100	-11.759 V		low values	
-32513	80FF		Underflow	From hex value 16#80FF on, the sensor value is	
-32768	8000	-11.851V		below the configured measurement value range and is no longer valid.	

## Analog value display in the ±10V voltage measuring range

## 7.3.4 Display of analog value of a 0-10V voltage measuring transducer

### Analog value display in the 0-10V voltage measuring range

Analog value representation		Voltage measuring range	Area of application	Remark		
Decimal	Hexadecim al					
32767	7FFF	11.851V	Overflow	From the hex value 16#7F00 on, the sensor value is above the overload range and is no longer valid.		
32512	7F00					
32511	7EFF	11.759V	Overload range	This range corresponds to a tolerance band before		
27644	6C01			the overflow is reached. Within this measuring range, the resolution is no longer optimal		
27648	6C00	10V	Nominal range	The nominal range is the normal range for		
20736	5100	7.5V		recording measurement values. This range		
1	1	361.7µV		guarantees optimal resolution		
0	0	0V	]			
			Undershoot range	Negative values are not supported		

## 7.3.5 Analog value display of a standard PT100

## Analog value display for a standard PT100 resistance thermometer

Analog value representation		Voltage measuring range	Area of application	Remark		
Decimal	Hexadecim al					
32.767	7FFF	> 1,000°C	Overflow	From the hex value 16#2711 on, the sensor value is above the overload range and is no longer valid.		
10.000	2710	1,000°C	Overload range	This range corresponds to a tolerance band before the overflow is reached. Within this measuring		
8.501	2135	850.1°C		range, the resolution is no longer optimal		
8.500	2134	850°C	Nominal range	The nominal range is the normal range for		
				recording measurement values. This range		
				guarantees optimal resolution		
-2.000	F830	-200 °C				
-2.001	F82F	-200.1 °C	Undershoot range	Range corresponding to the overload range but for low values		
				low values		
-2.430	F682	-243 °C				
-2431	F681		Underflow From hex value 16#F681 on, the sensor val			
-32.768	8000	< -243 °C		below the configured measurement value range and is no longer valid.		

7.3 Analog value representation

## 7.3.6 Effect of the PT100 wiring on the analog value display

### Overview

The PT 100 wiring significantly influences the measured value acquisition. The connecting cables from the SM331 module to the PT100 thermometer have a resistance that is independent of the conducting material, the length, and the cable cross-section. If you want to compensate for this cable resistance, you must select the 4-wire connection or 3-wire connection.

Measure the ambient temperature with the 3 PT100s and a cable resistance of 5 Ohms (170m copper cable, 0.6mm2). The following measured values will be displayed:

### Influence of the wiring on the temperature acquisition

PT100 connection variants	Ambient temperature	Analog value representation	measured temperature	Absolute error
4-cables	17.0°C	00AA Hex.	17.0°C	0°C
3-cables	17.0°C	013C Hex.	31.6°C	14.6°C
2-cables	17.0°C	01BD Hex.	44.5°C	27.5°C

60	66" 44 66"	1 R.		X 2 X X	- 0 ×	Ð	
	Address	Symbol	Display format	Status value	Modify		
1	// Channel val						2
2	DB1.DBW 0		HEX	W#16#0000			9
3	DB1.DBW 2		HEX	W#16#0000		4	1
4	DB1.DBW 4		HEX	W#16#009C		-	1
5	DB1.DBW 6		HEX	W#16#7FFF			L 16
6	DB1.DBW 8		HEX	W#16#0114			5 /
7	DB1.DBW 10		HEX	W#16#7FFF			
8	DB1.DBW 12		HEX	W#16#01AF			
9	DB1.DBW 14		HEX	W#16#7FFF			
10							
11	// Analog valu	es					
12	DB2.DBD 0		FLOATING_POINT	0.0			
13	DB2DBD 4		FLOATING_POINT			_	
14 15	DB2DBD 8		FLOATING_POINT	and the second se			- 1
15	DB2.DBD 12		FLOATING_POINT	431			
16 17	// Process cor	trol status		La			
17	M 200.0		BOOL	talse	10 million 12		
18	MW 100		BIN	2#0000_0000_0000_0000	)		

Direct comparison of the three wiring options

- (1) PT100 4-wire connection
- (2) PT100 3-wire connection
- (3) PT100 2-wire connection

7.3 Analog value representation

#### Note

The cable resistance does not rise along with the temperature. It remains constant. If you are measuring high temperatures, the inaccuracy is reduced by a percentage value.

Testing the user program

7.3 Analog value representation

# 8

# **Diagnostic interrupt**

# 8.1 Initiating the diagnostic interrupt

#### **General information**

Diagnostic interrupts enable the user program to react to hardware errors.

Modules must have diagnostic capabilities in order to also be able to generate diagnostic interrupts.

In OB82, you program the reactions to diagnostic interrupts.

#### **Diagnostic interrupt**

Analog input module SM331 Al8x12bit has diagnostic capabilities.

Diagnostic interrupts that occur are signaled by the red "SF" LED on the SM331 module and on the CPU (see red circle).

Generating a hardware error

Graphic	Description
	Remove the power supply at terminal 1 on the front connector of the module or terminal Y on the TOP connect terminal block.
	Result: A diagnostic interrupt is initiated; the red "SF" LED lights up.

8.1 Initiating the diagnostic interrupt

The cause of the error can be determined "online" by requesting the hardware status. .

In order to determine the state of module "online", proceed as follows:

- In the hardware configuration, click on the SM331
- In the target system / module status menu, call up the hardware diagnostics

🔣 HW Config - [SIMATIC	300-Station (Configuration) GS	5M331T2D]
📲 Station Edit Insert	PLC View Options Window Help	
	Download Upload	Ctrl+L
(0) UR 1	Download Module identification Upload Module Identification to PG	,
2 CPU315-2 X2 DP	Faulty Modules	
3	Module Information	Ctrl+D
4 Al8x12Bit 5 6	Operating Mode Clear/Reset Set Time of Day	Ctrl+I
igure 8-1 Module status		

Figure 8-1 Module status

8.2 General diagnostic message

# 8.2 General diagnostic message

#### **Diagnostic interrupt tab**

On the Diagnostic Interrupt tab, you will find information about the reported error. Any interrupts that occur are not channel dependent and apply to the entire module.

Module Information - AI8x12Bit	_ 🗆 X
Path: GSSM331T2D\SIMATIC 300-Station\CPU31 Operating mode of the CPU:  The Arror  Comparison of the CPU:  Comparison of the CP	1
General Diagnostic Interrupt	
Standard Diagnosis of the Module:	
External error Faulty module No external auxiliary voltage Channel-Specific Diagnosis (Channel No. 0 to Maximum):	
Channel no. Error	
Help on selected diagnostic row: Display	
Close Update Print	Help

Figure 8-2 Diagnostics for SM331

# 8.3 Channel-linked diagnostic messages

#### 8.3.1 Types of diagnostic messages

#### Channel-linked diagnostic messages

There are five types of channel-linked diagnostic messages:

- Configuration / programming error
- Common mode error
- Wire break
- Underflow
- Overflow

#### Note

This only shows you the channel-linked diagnostics for measuring modes of 2 or 4-wire current transducers. Other measuring modes are similar but are not described here.

#### 8.3.2 Configuration / programming error

#### Meaning

The position of the measuring range modules does not match the measuring mode set in the hardware configuration.

#### 8.3.3 Common mode error

#### Meaning

The voltage difference  $U_{\rm cm}$  between the inputs (M-) and the common voltage potential of the measuring circuit (M\_{ana}) is too high.

In the example, this error cannot occur because  $M_{\text{ana}}$  was connected to M for the voltage measuring transducer.

# 8.3.4 Wire breakage (only for the PT100 measuring mode)

#### Meaning

If the measuring mode is set to voltage, there is no way to check a wire breakage. You also cannot select it in SIMATIC Manager. In PT100 measuring mode, a wire breakage is detected and reported.

Module Information Althoused     the CPU Althouse CPU II Operating mode of the CPU OPENIN     share Concerning Transmission CPU II     Section CPU III     Section CPU IIII     Section CPU     Section CPU	Table Help		ALC VI		
Standard Diagnosis of the Module	a state of the	00 mm ( 60)	and the second second second		
External error Feully module	1000			Contraction of the	
There is a channel ente.		Address	Symbol	Deplay format	Status value
	I	DB1.DBW	0	HEX	W#15#000
	2	DB1.DBW	2	HEX	SALEH CHINE
	3	DB1.DBW	4	HEX <	WHITEH?FI
		DB1.DBW	6	HEX	W#16#7F
Channel-Specific Diagnosis (Channel No. 0 to Maximum)	5	D91.DBW	8	HEX	W#15#01
Channeline Eros	6	DB1DBW	10	HEX	W#15#7F
Orannel 2: Analog Input vice break	7	DB1.DBW	12	HEX	W#16#01
	0	DB1.DBW	14	HEX	WHIGH 7F
	9	082080	0	FLOATING POINT	0.0
	11		4	FLOATING POINT	32767
and the second	12	DB20BD	8	FLOATING POINT	27.6
Help on selected diagnostic row: Display	13	DR2DRD	12	FLOATING POINT	421
	14	Afric 10		HEY	Suller Canity
Close Update Pixe: Help	GSSM	STANDART CONTRACTOR	C 300-92.40x	an)	1)

Figure 8-3 Left: Diagnostic message with wire break / Right: Variable table

The analog value display immediately goes into the overflow range (HEX 7FFF), since the channel measures infinite resistance.

#### See also

Configuring the analog module (Page 6-10)

# 8.3.5 Underflow

#### Meaning

The two measuring modes, voltage and PT100, can initiate the diagnostic message "Analog input measuring range/lower limit value undershot".

#### Voltage

Module Infor	mation Althe 1284	-11 ×	×C.	a Control	Oniplay		- 0 >
	T2D/SIMATIC 300-Station/CPU31 Operating mode of the CPU		Table Inter	ER Per	RC YN	and the same station	a mindras
Standard Diago	osis of the Module			60° 40° 60			
External error Faulty module				Contrast Direction		CHARLES IN COLORADO	
There is a char	viel ercit.			Address	Symbol	Deplay format	Status value
			1	DB1.DEW	0	HEX	W#15#000
			2	WBC 780	2	HEX	W#15#000
			3	DB1 DBW	4	HEX	W#15#800
			4	DB1.DBW	6	HEX	W#16#799
Channel-Specifi	: Diagnosis (Channel No. 0 to Maximum).		5.	DB1.DBW	6	HEX	W#15#011
(Dannel no.	Env		6	DB1.DBW	10	HEX	WHIGH7FF
Diamel 0	Analog Input measuring range / Low limit exceeded		7	DB1 DBW	12	MEX	WEISBOLA
Channel 1:	Analog Input measuring range /Low test exceeded		8	DB1 DEW	14	MEX	W#1E#7FF
			9				
			10	DB20BD	0	FLOATING_POINT	-5.924273
			11	082080	4	FLOATING_POINT	122.5
	the second s		12	082080	8	FLOATING_POINT	27.6
Help on selecter	d dagnostic row Display		13	082060	12	FLOATING_POINT	43.1
min I	NOR I NOT I		10	48-1 10		HEV.	-
Close	Update Piez.	Heb	20043	OI TOO SIMAT	1C 300-Stats	ord 157-Producered	1

Figure 8-4 Left: Diagnostic display in the underflow range/Right: Variable table

We have connected the 2 channels in parallel in order to retain the diagnostic capability of the channel group. Logically, we also receive the diagnostic message for the second channel.

If you receive this message during commissioning, check to see whether the measuring range of the measuring transducer and its configuration match each other.

# PT100

Mudole Information - Alliet 202	X	PH v	or Lonkrol	Display		_ [[] ×
Tark: GSSM33T125/SIMATIC 300-Station/UPU3T Operating mode at the CPU III RUN Satur: III Contemporation		Table retty	E.R. Date	RC NW	able then Opposit	
General Disgnochi Interrupt		-141		Lat :	BRAN	X E 2
Standard Diagnosis of the Module		Ca	60 40 60		and the second second second	
External error Faulty module There is a channel error		-	sectored Daugh		PROFILE CONTRACT	
There is a channel ettor.			Address	Symbol	Display format	Status value
		1	Det.Dew	0	HEX	WIII1680000
		2	Det Dew	2	HEK	W#1680000
		3	Det.Dew	4	HEX	W#16#900
And the second		4	Det Dew	6	HEK	W#16#7FF
Oravvel-Specific Diagnoss (Charvel No. 0 to Maximum)		5	D61.D8W	8	HEX	W#16#011
Channelino Ensi		6	DB1.DBW	10	HEX	WEIGE/FF
Drannel 2: Analog input measuring range/ Low limit exceeded		7	DB1.DBW	12	NEX	WEIGEOLA
			D81.D8W	14	HEX	W121627FF
		9				
		10	D82.D8D	0	FLOATING_POINT	0.0
		11	De2 DeD	4	FLOATING_POINT	-3276.8
		12	D82D8D	8	FLOATING_POINT	27.6
Help on selected diagnostic row Display		13	De2DeD	12	FLOATING_POINT	43.1
Close Update Pint H	eb		APLC		ARM.	WHICHING
care open inter	-	635M3	BIT2D(SIMAT	IC 300-5tati	m)(57-Programm()	0 0

Figure 8-5 Left: Diagnostic display in the underflow range/Right: Variable table

This message is generated if the temperature is under -243 °C or if the PT100 has very low resistance. Most probably, the PT100 connected has a short-circuit or the PT100 is defective.

## 8.3.6 Overflow

#### Meaning

In the two measuring modes, voltage and PT100, the diagnostic message "Analog input measuring range/upper limit value exceeded" can be initiated.

# "Voltage" measuring mode

Module Information - AlBad 288	X	War Loninel	Ouplay		_ [] :
ah: ISSSM33172DVSMATIC3005tation/CPU31 Operating mode of the CPU I FUN alue Cont Serveral Diagnostic Interrupt	1	die Ant beer		and the second	
Standard Diagnosis of the Module					
External error F.e.ity module		Construct Doors		STATISTICS STATE	19-01-0
There is a channel error.		Address	Symb	of Depley format	Stabus value
		DB1 DBW	0	HEX	W#15#000
		DB1.DBW	2	HEX	W#15#300
		DB1 DBW	4	HEX	WEIGHOO
I have a serie of the series o		DB1.DBW	6	HEX	WHITEH 7FT
Channel-Specific Diagnosis (Diannel No. 0 to Maximum)		DB1 DBW	8	HEX	WHIEHOIT
Durreino Eso		DB1 DBW	10	HEX	WE15E7F
Channel 0. Analog Input measuring range / High limit exceeded		DB1.DBW	12	HEX	WHIEHOL
Channel 1: Analog Input measuring range / High limit exceeded		DB1.DBW	14	HEX	WHIEH TH
		1			
		DB2DED	0	FLOATING_POINT	5.924273
		DB2DED	4	FLOATING_POINT	122.5
		2 D82080	8	FLOATING_POINT	27.6
Help on relected diagnostic rosic Display		DR2DRD	12	FLOATING_POINT	431
Close Update Print Help		10 Land 10		HEV	LUTITE HOLY
Cone Coose Parts	6	SHOUT2D/SIMAT	TC 300-914	tion),)57-Programm()	1)

Figure 8-6 Left: Diagnostic message with overflow / Right: Variable table

### PT100 measuring mode

Modele Information - Allie1202	X	2 V	ar Lontrol D	velop		- 1012
eh: [USSM331172D/SH4A11C 300-Stateon/UPU3] Openating mode of the CPU ① RUN ehurExter		Table Holis	Edd Danet	PLC NY	able place Options	- Mindow
leneral Diagnostic Interrupt		41	DISID	alx	10000	XIE
Standard Diagnosis of the Module:			60° 48* ( 68°			
External ends Faulty module		-	united Depairs	And LONG	HITTI ILTI ILMAN	
There is a channel error.			ASSess	Symbol	Display Formiat	Status value
		T	DB1.DBW	0	HEX	W#168000
		2	D61.D8W	2	HEX	W#16200
		2	DB1.DBW	4	HEX	Walter
		4	Det Dew	6	HEX	W#15#7F
Diannel-Specific Diagnosis (Channel No. 0 to Maximum)		5	De1.DeW	8	HEX	W#16#01
Channel na Eno		6	Det.Dev/ 1		HEX	W#16#7F
Drannel 2: Analog Input measuring range / High limit exceeded		7	DB1.DBW 1	12	HEX	WEIEBOI
			Det.Dew 1	14	HEX	W#16#7F
		80	DE2DED C	1	FLOATING_POINT	0.0
		11	Dezbeb 4	1	FLOATING_POINT	-3276.8
		12	Dected 6	3	FLOATING_POINT	27.6
Help on selected diagnostic sterc Display		13	Deaded t	5	FLOATING_POINT	40.1
Date Update Print. H	6		APLY 10		HEY.	Gardenny

Figure 8-7 Left: Diagnostic message with overflow / Right: Variable table

# 9

# Hardware interrupt

# 9.1 Hardware interrupt

#### Overview

A special feature of the SM331 Al8x12bit is the capability to also trigger hardware interrupts. The two channels, 0 and 2, can be correspondingly configured.

#### Defining the limit values for hardware interrupts:

For the PT100 resistance thermometer, you must define the limit values in °C and not in °F or K.

For the voltage measuring transducer, you must define the limit values in Volts (V) and not in the unit of the connected sensor.

#### Example:

You have a pressure sensor with the physical unit in Pascals (Pa). You do not, however, specify the limit values in Pascals. Instead, you use the corresponding value of the voltage measuring transducer in Volts.

#### Features of hardware interrupt triggering

In order to trigger a hardware interrupt, the limit values have to be within the nominal range of the measuring mode.

#### Example:

You use a voltage measuring transducer  $(\pm 5V)$  with a nominal range of -5V and +5V. If you have entered -6V as the lower limit value, these settings are accepted by the system, but the hardware interrupt is never triggered, because the diagnostic interrupt (underflow of the nominal range) is always activated beforehand.

In our example, we have configured channel 0 (voltage measuring transducer) with the following limit values:

- Lower limit value -3V
- Upper limit value +3V

If these values are undershot or exceeded within the nominal value range, hardware interrupt OB40 is triggered.

#### 9.1 Hardware interrupt

#### **OB40** hardware interrupt

Hardware interrupts generally trigger alarm organization blocks in the CPU. In our example, OB40 is called up.

In the STEP 7 program, OB40 is used for hardware interrupts. Depending on the CPU, several hardware interrupts can be configured.

If a hardware interrupt occurs, OB40 is called up. In the OB40 user program, you can program the reaction of the automation system to hardware interrupts.

In the example user program, OB40 reads the cause of the hardware interrupt. This can be found in temporary variable structure OB40\_POINT\_ADDR (local bytes 8 to 11).

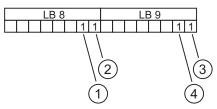


Figure 9-1 OB40 start information: Which event has violated limits and triggered a hardware interrupt

- (1) Value exceeds upper limit in channel 1
- (2) Value exceeds upper limit in channel 0
- (3) Violation of the lower limit in channel 0
- (4) Violation of the lower limit in channel 1

In the example, OB40 only transfers local data variables LD8 and LD9 into a marker word (MW100). The marker word is monitored in the existing variable table.

You can acknowledge the marker word in OB1 by setting marker bit M200.0 or by setting it to TRUE in the variable table.

#### Simulation of a hardware interrupt

If you provide channel 0 with 4V using a calibration device, you will receive the binary value 0000 0001 0000 0000 in MW100. This means that OB40 was called up and the upper limit of >4V has been exceeded in channel 0.

**		PLC Y	6	Window Help		+	4.0 1	5
	Address		bol Display format	Status value	Modify		A COLUMN TWO IS NOT	A CONTRACTOR OF
	// Channel		1.11	111102-00-005				
1	DB1.DBW	0	HEX	W#16#0000			CALIBRATOR DI	
	DBIRGW	2	HEX	W#16#0000				
	DB1.DBW	4	HEX	W#15#009C				
	081.08W	6	HEX	W#16#7FFF				
	D61.DEW	0	HEX	Wa16#0114				
	DB1.DBW	10	HEX	WIE15#7FFF				
	DB1.DBW	12	HEX	W#16#01AF				
	DB1.DBW	14	HEX	W#16#7FFF		11	28.4	20 A 10
0							100	-
1	// Analog v	akues						
2	DB2DBD	0	FLOATING_POINT	4.000499				_
3	DB2DBD	4	FLOATING_POINT	15.6		110	200 mii	20 mA
4	082080	8	FLOATING_POINT	27.6		-		
012345678	DB2DBD	12	FLOATING_POINT	43.1			-	~
6	// Process of	control sta	êus:					100
7	M 200.0		800L	false		1	_	
8	MW 100		HEX	2#0000_0000_0000	_0000	arch	-	V

Figure 9-2 Process interrupt: Violation of lower limit in channel 0

Hardware interrupt

9.1 Hardware interrupt

# A

# Appendix

# A.1 Source code of the user program

#### Overview

In this section, you can get a quick overview of the functions of the user program for the example station. A flowchart shows you the rough outline of the program structure. You will find the complete program in detail in the STL source code.

For your own use, you can also download the STL source code directly in the form of an STL file from the HTML page from which you loaded this "Getting Started" manual.

#### Flowchart

The texts marked in red correspond to the source code in the user program.

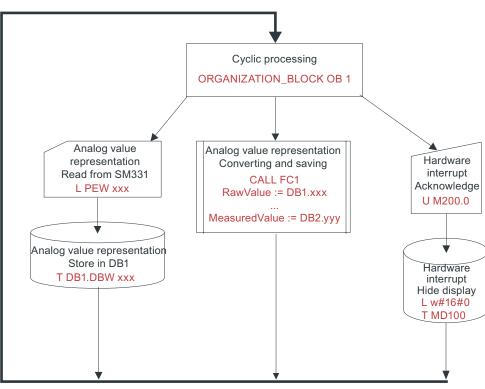


Figure A-1 OB1 Flowchart

SM331;AI 8x12 Bit Getting Started Part 2: Voltage and PT100 Getting Started, 11/2006, A5E00264161-02

A.1 Source code of the user program

#### Variable description

Variables	Description
DB1.DBW 0	Channel 0 Display of analog value
DB1.DBW 2	Channel 1 Display of analog value
DB1.DBW 4	Channel 2 Display of analog value
DB1.DBW 6	Channel 3 Display of analog value
DB1.DBW 8	Channel 4 Display of analog value
DB1.DBW 10	Channel 5 Display of analog value
DB1.DBW 12	Channel 6 Display of analog value
DB1.DBW 14	Channel 7 Display of analog value
DB2.DBD 0	Measuring transducer 1 voltage (V)
DB2.DBD 4	PT100 with 4-wire connection (°C)
DB2.DBD 8	PT100 with 3-wire connection (°C)
DB2.DBD 12	PT100 with 2-wire connection (°C)
M200.0	Acknowledge hardware interrupt
MW 100	Status hardware interrupt

#### STL source code

```
DATA BLOCK DB 1
TITLE =Analog value display
VERSION : 0.1
  STRUCT
    CH_0 : INT;
                      //Channel 0
    CH_1 : INT;
                      //Channel 1
    CH_2 : INT;
                      //Channel 2
    CH_3 : INT;
                      //Channel 3
                      //Channel 4
    CH_4 : INT;
    CH_5 : INT;
                      //Channel 5
    CH_6 : INT;
                      //Channel 6
    CH_7 : INT;
                      //Channel 7
  END_STRUCT ;
BEGIN
     CH_0 := 0;
    CH_1 := 0;
    CH 2 := 0;
    CH 3 := 0;
     CH_4 := 0;
     CH 5 := 0;
    CH 6 := 0;
     CH_7 := 0;
END_DATA_BLOCK
```

A.1 Source code of the user program

```
DATA BLOCK DB 2
TITLE =process values
VERSION : 0.1
  STRUCT
     SE 1 : REAL ;
                              //Voltage Transducer
     SE 2 : REAL ;
                              //PT100 (4)
     SE 3 : REAL ;
                              //PT100 (3)
     SE 4 : REAL ;
                              //PT100 (2)
  END STRUCT ;
BEGIN
     SE_1 := 0.000000e+000;
     SE_2 := 0.000000e+000;
     SE 3 := 0.000000e+000;
     SE 4 := 0.000000e+000;
END_DATA_BLOCK
FUNCTION FC 1 : VOID
TITLE =Converting analog value display to process values
VERSION : 0.1
VAR INPUT
  RawValue : INT;
  Factor : REAL ;
  Offset : REAL ;
  OverFlow : INT;
  OverRange : INT;
  UnderRange : INT;
  UnderFlow : INT;
END_VAR
VAR OUTPUT
  MeasuredValue : REAL ;
  Status: WORD ;
END_VAR
VAR_TEMP
  TInt : INT;
  TDoubleInt : DINT ;
  TFactor : REAL ;
  TOffset : REAL ;
  TFactor1 : DINT ;
  TFactor2 : REAL ;
END VAR
BEGIN
NETWORK
TITLE = Conversion
            L
               #RawValue;
            ITD ;
            DTR ;
```

A.1 Source code of the user program

	L #Fa	actor;
	*R ;	
	L #Of	fset;
	+R ;	
	M #M∈	asuredValue;
NETWORK		
TITLE =Anal	log value	display monitoring
	L	W#16#0;
	М	#Status;
	L	<pre>#RawValue;</pre>
	L	#OverFlow;
	$\geq =I$	;
	JC	m_of;
	L	<pre>#RawValue;</pre>
	L	#OverRange;
	>=I	;
	JC	m_or;
	L	#Raw#
		#Raw# Value;
	L	UnderFlow;
	<=I JC	;
	JC	m_uf;
	L	#RawValue;
	L	#UnderRange;
	<=I	;
	JC	m ur;
		_
	JL	end;
m_of: L	W#16#80	);
	М	#Status;
	JL	end;
m_or: L	W#16#40 0;	
	М	#Status;
	JL	end;
<b>6</b> –		~
m_uf: L	W#16#20	
	M	#Status;
	JL	end;

A.1 Source code of the user program

```
m ur: L W#16#100;
            М
                      #Status;
             JL
                      end;
end: NOP 0;
END FUNCTION
ORGANIZATION BLOCK OB 1
TITLE = "Main Program Sweep (Cycle)"
VERSION : 0.1
VAR TEMP
                                      //Bits 0-3 = 1 (Coming event), Bits 4-7 = 1 (Event class 1)
  OB1 EV CLASS : BYTE ;
                                      //1 (Cold restart scan 1 of OB 1), 3 (Scan 2-n of OB 1)
  OB1_SCAN_1 : BYTE ;
  OB1 PRIORITY : BYTE ;
                                      //Priority of OB Execution
  OB1 OB NUMBR : BYTE ;
                                      //1 (Organization block 1, OB1)
  OB1 RESERVED 1 : BYTE ;
                                      //Reserved for system
  OB1 RESERVED 2 : BYTE ;
                                      //Reserved for system
                                      //Cycle time of previous OB1 scan
(milliseconds)
  OB1_PREV_CYCLE : INT;
  OB1_MIN_CYCLE : INT;
                                      //Minimum cycle time of OB1
(milliseconds)
                                      //Minimum cycle time of OB1
(milliseconds)
  OB1 MAX CYCLE : INT;
  OB1 DATE_TIME : DATE_AND_TIME ;
                                     //Date and time OB1 started
END VAR
BEGIN
NETWORK
TITLE =Transfer of the channel values to data block DB 1
// Channel 0 -> Data block
            L PEW 256;
               DB1.DBW
            М
                              0;
// Channel 1 -> Data block
            L PEW 258;
            M DB1.DBW
                              2:
// Channel 2 -> Data block
            L PEW 260;
               DB1.DBW
            М
                              4;
// Channel 3 -> Data block
            L PEW 262;
            М
               DB1.DBW
                              6;
// Channel 4 -> Data block
```

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A.1 Source code of the user program

	L PEV	1 264;				
		.DBW	8;			
			-,			
// Channel	5 -> Dat L PEW					
	M DB1	.DBW	10;			
// Channel	6 -> Dat L PEW					
	M DB1	.DBW	12;			
// Channel	7 -> Dat L PEW					
	M DB1	.DBW	14;			
NETWORK		ha awala		1 1		1
TITLE =Conv	verting t	ne analo	og value d	usp.	lay -> measured v	value
// Channel	1 : Volt CALL FC	-	suring tra	ınsdı	acer 1 to 5V	
		RawVa	lue	:=	DB1.DBW	Ο,
		Facto	r	:=	1.447000e-004,	
		Offse	t	:=	1.000000e+000,	
		OverF	low	:=	32512,	
		OverR	ange	:=	27649,	
		Under	Range	:=	-1,	
		Under	Flow	:=	-4865,	
		Measu	redValue	:=	DB2.DBD	Ο,
		Statu	S	:=	FW	10);
// Channel	2 : PT10 CALL FC					
		RawVa	lue	:=	DB1.DBW	4,
		Facto	r	:=	1.000000e-001,	
		Offse	t	:=	0.000000e+000,	
		OverF	low	:=	10001,	
		OverR	ange	:=	8501,	
		Under	Range	:=	-2001,	
		Under	Flow	:=	-2431,	
		Measu	redValue	:=	DB2.DBD	4,
		Statu	S	:=	FW	20);
// Channel	3 : PT10 CALL FC					
	011212 1 0	⊥ ( RawVa	lue	:=	DB1.DBW	8,
		Facto			1.000000e-001,	÷,
		Offse			0.000000e+000,	
		21100	-	•		

A.1 Source code of the user program

	OverFlow	:= 10	001,	
	OverRange	:= 85	01,	
	UnderRange	:= -2	001,	
	UnderFlow	:= -2	431,	
	MeasuredValue	:= DB	2.DBD	8,
	Status	:= FW		30);
// Channel 4 : PT 10	0			
CALL FC	1 (			
	RawValue	:= DB	1.DBW	12,
	Factor	:= 1.	000000e-001,	
	Offset	:= 0.	000000e+000,	
	OverFlow	:= 10	001,	
	OverRange	:= 85	01,	
	UnderRange	:= -2	001,	
	UnderFlow	:= -2	431,	
	MeasuredValue	:= DB	2.DBD	12,
	Status	:= FW		40);
NETWORK				
TITLE = Acknowledge h	hardware interru	ot		
U M	200.0:			

NETWORK	
TITLE =	A

тттпр	_	ACK	помтеай	уe	naruwa	are	THLETT
			U	М		200	.0;
			EP	М		200	.1;
			SPBN	m(	)01;		
			L	0;	;		
			М	FI	C	100	;
			М	F٧	v	104	;
			М	FV	V	106	;
			R	М		200	.0;
m001:			NOP	0;	;		

#### END\_ORGANIZATION\_BLOCK

ORGANIZATION\_BLOCK OB 40 TITLE = "Hardware Interrupt" VERSION : 0.1

#### VAR TEMP

OB40_EV_CLASS : BYTE ;	//Bits $0-3 = 1$ (Coming event), Bits $4-7 = 1$ (Event class 1)
OB40_STRT_INF : BYTE ;	//16#41 (OB 40 has started)
OB40_PRIORITY : BYTE ;	//Priority of OB Execution
OB40_OB_NUMBR : BYTE ;	<pre>//40 (Organization block 40, OB40)</pre>
OB40_RESERVED_1 : BYTE ;	//Reserved for system
OB40_IO_FLAG : BYTE ;	//16#54 (input module), 16#55 (output module)
OB40_MDL_ADDR : WORD ;	//Base address of module initiating interrupt

A.1 Source code of the user program

```
OB40 POINT ADDR : DWORD ;
                                       //Interrupt status of the module
  OB40 DATE TIME : DATE AND TIME ;
                                       //Date and time OB40 started
END VAR
BEGIN
NETWORK
TITLE =
                                                         : 16#54 = input
module
            L
                #OB40 IO FLAG;
                                       //OB40 IO FLAG
            М
               MB
                                104;
                                      11
                                                         : 16#55 = output
                                                         module
            L
                #OB40 MDL ADDR;
                                       //OB40 MDL ADDR
                                                           Start address of
                                                         : Si
the
            Μ
                FW
                                106;
                                       11
                                                         module to be
                                                         triggered
                #OB40 POINT_ADDR;
                                       //OB40_POINT_AD
                                                         : L
the
                                                           LB8 = Exceeding
            L
                                                         upper limit value
                                100;
                                       11
                FD
            М
                                       //OB40_POINT_AD
          NOP
                0:
                                                           LB9 =
                                       ĎŔ
                                                         Undershooting the
          NOP
                0:
                                       //
                                                         lower limit value
END ORGANIZATION BLOCK
ORGANIZATION BLOCK OB 82
TITLE = "I/O Point Fault"
VERSION : 0.1
VAR TEMP
                                    //16#39, Event class 3, Entering event state, Internal fault event
  OB82 EV CLASS : BYTE ;
  OB82 FLT ID : BYTE ;
                                    //16#XX, Fault identification code
                                    //Priority of OB Execution
  OB82 PRIORITY : BYTE ;
  OB82 OB NUMBR : BYTE ;
                                    //82 (Organization block 82, OB82)
  OB82 RESERVED 1 : BYTE ;
                                    //Reserved for system
  OB82 IO FLAG : BYTE ;
                                    //Input (01010100), Output (01010101)
  OB82 MDL ADDR : WORD ;
                                    //Base address of module with fault
                                    //Module defective
  OB82 MDL DEFECT : BOOL;
  OB82_INT_FAULT : BOOL;
                                    //Internal fault
  OB82 EXT FAULT : BOOL;
                                    //External fault
  OB82 PNT INFO : BOOL;
                                    //Point information
  OB82_EXT_VOLTAGE : BOOL;
                                    //External voltage low
  OB82 FLD CONNCTR : BOOL;
                                    //Field wiring connector missing
  OB82 NO CONFIG : BOOL;
                                    //Module has no configuration data
  OB82_CONFIG_ERR : BOOL;
                                    //Module has configuration error
  OB82_MDL_TYPE : BYTE ;
                                    //Type of module
  OB82 SUB MDL ERR : BOOL;
                                    //Sub-Module is missing or has error
  OB82 COMM FAULT : BOOL;
                                    //Communication fault
  OB82 MDL STOP : BOOL;
                                    //Module is stopped
  OB82_WTCH_DOG_FLT : BOOL;
                                    //Watch dog timer stopped module
  OB82 INT PS FLT : BOOL;
                                    //Internal power supply fault
  OB82 PRIM BATT FLT : BOOL;
                                    //Primary battery is in fault
```

#### A.1 Source code of the user program

```
OB82_BCKUP_BATT_FLT : BOOL;
                                //Backup battery is in fault
  OB82 RESERVED 2 : BOOL;
                                 //Reserved for system
                                 //Rack fault, only for bus interface
module
  OB82_RACK_FLT : BOOL;
  OB82_PROC_FLT : BOOL;
                                 //Processor fault
  OB82_EPROM_FLT : BOOL;
                                 //EPROM fault
  OB82_RAM_FLT : BOOL;
                                //RAM fault
  OB82_ADU_FLT : BOOL;
                                 //ADU fault
  OB82_FUSE_FLT : BOOL;
                                //Fuse fault
  OB82_HW_INTR_FLT : BOOL;
                                 //Hardware interrupt input in fault
  OB82_RESERVED_3 : BOOL;
                                //Reserved for system
  OB82 DATE TIME : DATE AND TIME //Date and time OB82 started
END_VAR
BEGIN
END_ORGANIZATION_BLOCK
```

#### See also

General information (Page 1-1)

A.1 Source code of the user program

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